

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

NASA CR-144948-1

Part 1 of 3

A COMPILATION OF SPACECRAFT LOADS DATA
FROM
FOUR TITAN CENTAUR LAUNCH VEHICLE FLIGHTS
VOLUME V: TIME HISTORY PLOTS

Compiled by George Kachadourian

(NASA-CR-144948-Pt-1) A COMPILATION OF
SPACECRAFT LOADS DATA FROM FOUR TITAN
CENTAUR LAUNCH VEHICLE FLIGHTS. VOLUME 5,
PART 1: TIME HISTORY PLOTS (General
Electric Co.) 41 p HC A03/MF A01 CSCL 22B G3/15

N77-28193

Unclas
42487



Prepared under Contract No. NAS1-9100 by
GENERAL ELECTRIC COMPANY
Viking Project Support Services
Hampton, Virginia

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

January 1977

A COMPILATION OF SPACECRAFT LOADS DATA
FROM
FOUR TITAN CENTAUR LAUNCH VEHICLE FLIGHTS
VOLUME V: TIME HISTORY PLOTS

January 1977

ABSTRACT

The payloads carried by the first four Titan Centaur Launch Vehicle Flights were, a Viking Spacecraft Dynamic Simulator, the Helios-A Spacecraft and the two Viking Spacecraft. Dynamic loads data was accumulated by the NASA Viking Project Office from these four flights for application to the Viking Spacecraft. This report contains a compilation of that data and is presented for reference and information. The data has been compiled into the following five volumes:

- Volume I - Acoustic Data - NASA CR-144944
- Volume II - Vibration Power Spectral Density Data - NASA CR-144945
- Volume III - Shock Spectra of Transients - NASA CR-144946
- Volume IV - Titan Stage I and Centaur Burn Oscillation - NASA CR-144947
- Volume V - Time History Plots - NASA CR-144948

1. Report No. NASA CR-144948		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle A Compilation of Spacecraft Loads Data From Four Titan Centaur Launch Vehicle Flights Volume V: Time History Plots				5. Report Date January 1977	
				6. Performing Organization Code	
7. Author(s) George Kachadourian				8. Performing Organization Report No.	
9. Performing Organization Name and Address General Electric Company Viking Program Support Services 17 Research Road, Hampton, Va. 23666				10. Work Unit No.	
				11. Contract or Grant No. NAS1-9100	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Langley Research Center, Hampton, Va. 23665				13. Type of Report and Period Covered Contractor Report	
				14. Sponsoring Agency Code	
15. Supplementary Notes This report is a compilation of data processed by the Langley Research Center Analysis and Computation Division under the direction of the Viking Project Office.					
16. Abstract The payloads carried by the first four Titan Centaur Launch Vehicle flights were a Viking Dynamic Simulator, the Helios A Spacecraft and the two Viking Spacecraft. Dynamic loads data were gathered by the NASA Viking Project Office from these four flights for applications to the Viking Spacecraft. This volume contains time histories of all of the data processed at LRC for the Viking Flights.					
17. Key Words (Suggested by Author(s)) Viking Spacecraft, Titan Centaur Acoustic Vibration Dynamic Loads			18. Distribution Statement Unclassified		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price*		

Notations Used in Volume V

Bus -	Major structural assembly of Viking Orbiter - See Figure 3.1
FBR -	Forward Bearing Reaction - Centaur to Centaur Standard Shroud
FLMN -	First Longitudinal Mode Noise
Max Q -	Period of launch flight of maximum dynamic pressure
MECO -	Centaur Main Engine Cut Off
MES -	Centaur Main Engine Start
PSD -	Power spectral density, vibration, g^2 /Hertz
VDS -	Viking Dynamic Simulator, TC-1 payload
VLC -	Viking Lander Capsule
VLCA -	Viking Lander Capsule Adapter
VO -	Viking Orbiter
VS/C -	Viking Spacecraft
V-S/C-A-	Viking Spacecraft Adapter
SRM -	Solid Rocket Motor - Titan Stage 0
TC-1 -	The Titan Centaur Launch Vehicle Number 1
TC-2 -	The Titan Centaur Launch Vehicle Number 2, Helios Spacecraft
TC-3 -	The Titan Centaur Launch Vehicle Number 3, Second Viking Spacecraft launch
TC-4 -	The Titan Centaur Launch Vehicle Number 4, First Viking Spacecraft Launch

VOLUME V
TIME HISTORY PLOTS
CONTENTS

Contents Description

Table 1 -	TC-1 Instrument List
Table 2 -	TC-4 & TC-3 Instrument List
Table 3 -	TC-1 to TC-3 & 4 Measurement Correspondence
Table 4 -	Transform Data List
Table 5 -	Matrix of Time History Plots - TC-1
Table 6 -	Matrix of Time History Plots - TC-4
Table 7 -	Matrix of Time History Plots - TC-3

Figures

1	Viking Spacecraft Instrument Locations
2-183	Time History Plots - (See Tables 5, 6 & 7)

Description of Contents

This volume contains time history plots of spacecraft measurements from the flights of TC-1, TC-4 and TC-3. Some of the time histories are also shown in other volumes of this report showing the two second time samples associated with a particular data analysis plot. The time histories of Volume V are for longer periods of time, showing the complete period of interest. Volume V also presents time histories of parameters which were generally not analyzed into PSD or shock spectra and which consequently do not appear any place else in the report. The time histories are presented in groups as indicated in Tables 5, 6 and 7, so that time phasing of measurements and transformed parameters are facilitated.

Table 1. . VDS MEASUREMENT LIST CENTAUR FM/FM #2 2215.5 MHz (TC-1)

VCO Number	Measurement Number	Description	Zero Load Bias	Full Scale Range	Filter Cutoff Frequency (Hz)	
					A	B
3	CY216-S	V-S/C-A Axial Load Transducer	59%	25342 lbs	—	—
4	CY215-S	V-S/C-A Axial Load Transducer	59%	25331 lbs	—	—
5	CY208-φ	VODS Sprung Mass Z-Axis Accelerometer	20%	10.01 g's	—	—
6	CY207-φ	VODS Bus X-Axis Accelerometer	50%	10.00 g's	—	—
7	CY206-φ	VODS Bus Y-Axis Accelerometer	50%	9.99 g's	—	—
8	CY205-φ	VODS Bus Y-Axis Accelerometer	50%	10.01 g's	45	90
9	CY204-φ	VODS Bus Z-Axis Accelerometer	50%	20.00 g's	200	118
10	CY203-φ	VODS Bus Z-Axis Accelerometer	50%	19.98 g's	180	162
11	CY202-φ	VODS Bus Z-Axis Accelerometer	50%	20.00 g's	160	—
12	CY214-S	PFLA Truss Axial Load, Member 202	59.6%	27177 lbs	153	—
13	CY213-S	PFLA Truss Axial Load, Member 203	61.0%	27192 lbs	145	—
14	CY212-S	PFLA Truss Axial Load, Member 204	61.1%	27157 lbs	140	—
15	CY211-S	PFLA Truss Axial Load, Member 205	59.2%	26636 lbs	137	—
16	CY210-S	PFLA Truss Axial Load, Member 206	60.1%	27175 lbs	135	—
17	CY209-S	PFLA Truss Axial Load, Member 201	61.6%	27319 lbs	134	—
18	CY201-φ	Piezoelectric Accelerometer, Z-Axis	50%	40.0 g's	133	2100
19	CY217-Y	Acoustic Microphone	50%	150.0 dB	—	2800
CENTAUR FM/FM #1 2208.5 MHz						
19	CA886Y	Acoustic Microphone Fwd Equip Comp	50%	150.0 db	—	—

A. Filter set used with 1024 sps digitization rate. Design for minimum phase error (below 40 Hz) between channels 9 through 18.

B. Filter set used with 8192 sps digitization = double standard IRIG

TABLE 2. FM/FM TELEMETRY INSTRUMENTATION, 2208.5 MHz LINK - VIKING - TC-4 & TC-3

MEAS. NO.	DESCRIPTION	JPL DESIGNATION	RANGE		UNIT	A G C U R A C Y	FM/FM CHANNEL	FILTER CUT OFF FREQUENCY - Hz	
			LOW	HIGH				A 1024 SPS	B 4096 SPS
CY186Y	Fwd.Equip.Comp.Amb.	-	120	150	db	5%	19	—	2800
CY182Ø	Longit.Vib; Foot H	2001AC1	-30	30	G	5%	18	133	2100
CY183Ø	Radial Vib.; Bay 7/8	2001AC2	-12	+12	G	5%	17	134	1580
CY134Ø	Longit. Vib., Foot C	2001AC3	- 5	+ 5	G	5%	16	135	1200
CY185Ø	Longit. Vib., Foot R	2001AC4	- 5	+ 5	G	5%	15	137	900
CY186S	VLCA #750 Strain 1	2001SG1	10000C	8000T	Lbs	5%	14	140	—
CY187S	VLCA #751 Strain 2	2001SG2	10000C	8000T	Lbs	5%	13	145	—
CY188S	VLCA #752 Strain 3	2001SG3	10000C	8000T	Lbs	5%	12	153	—
CY189S	VLCA #753 Strain 4	2001SG4	10000C	8000T	Lbs	5%	11	160	—
CY190S	VLCA #754 Strain 5	2001SG5	10000C	8000T	Lbs.	5%	10	180	—
CY191S	VLCA #755 Strain 6	2001SG6	10000C	8000T	Lbs.	5%	9	200	—
CY192P	VLC Bioshield DP		-0.25	0.75	PSID	5%	4	—	—
CY193P	VLC Bioshield Press.		0	16	PSIA	5%	3	—	—

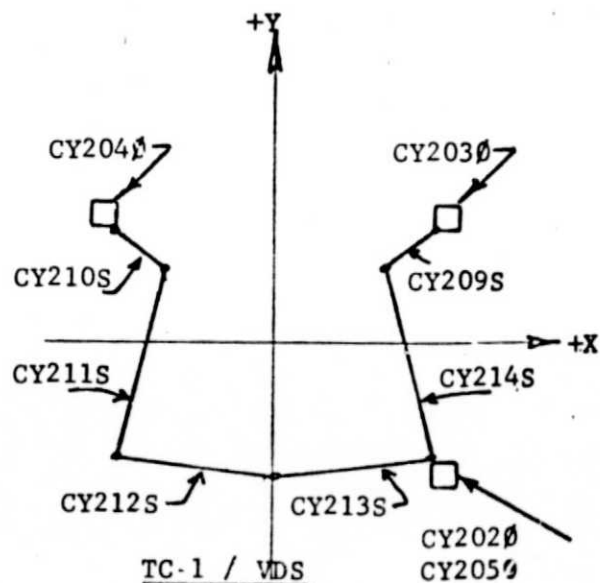
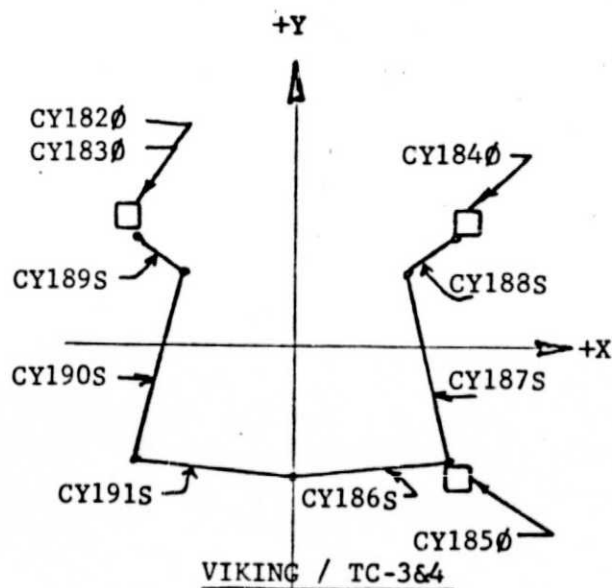
① Range shown is max limit. Each gage will have a different range dependent on its calibration value.

A. This is a special set of filters which, in conjunction with discriminator characteristics, results in phase errors of less than 1° between VCO 9 through 18 below 40 Hz

B. These are twice the standard IRIG filter.

TABLE 3. MEASUREMENTS CORRESPONDENCE
VIKING SPACECRAFT TO VDS

VIKING (TC-4 & 3)		VDS (TC-1)	
IRIG NO.	SENSOR		IRIG NO.
9	CY191S	↔	CY212S 14
10	CY190S	↔	CY211S 15
11	CY189S	↔	CY210S 16
12	CY188S	↔	CY209S 17
13	CY187S	↔	CY214S 12
14	CY186S	↔	CY213S 13
15	CY185Ø	↔	CY201Ø 18
16	CY184Ø	↔	CY203Ø 10
17	CY183Ø	↔	CY205Ø 8
18	CY182Ø	↔	CY204Ø 9



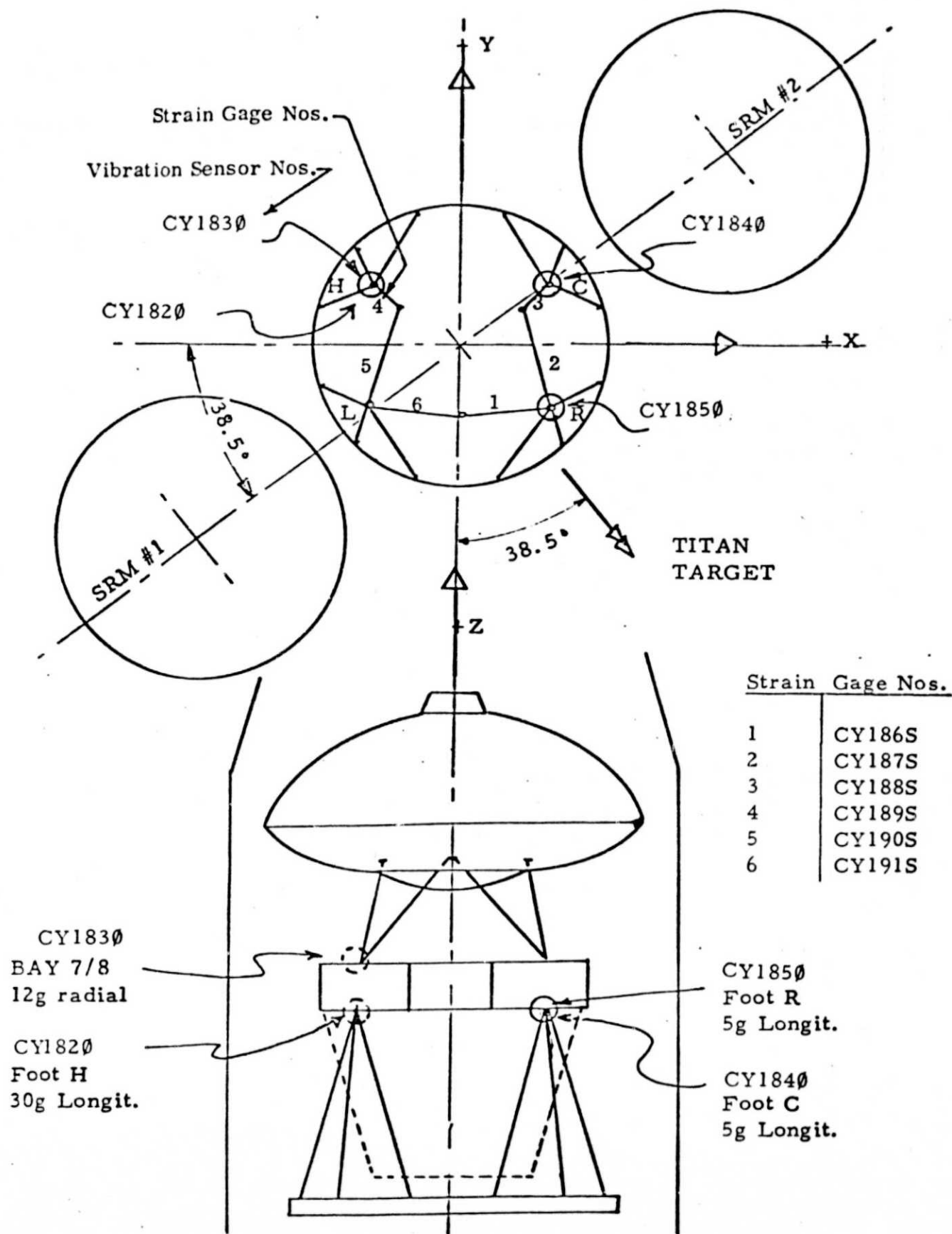


FIGURE 1 VIKING SPACECRAFT INSTRUMENT LOCATIONS

TABLE 4. TRANSFORM DATA LIST

- a. The following parameters were obtained from transform of the VLCA strain data, assuming the Lander to be rigid.

Number	Description
FXB	X axis resultant force, VLCA base
FYB	Y axis resultant force, VLCA base
FZB	Z axis resultant force, VLCA base
MXB	Moment about X axis at VLCA base
MYB	Moment about Y axis at VLCA base
MZB	Moment about Z axis at VLCA base
XDDL	X axis acceleration of VLC cg
YDDL	Y axis acceleration of VLC cg
ZDDL	Z axis acceleration of VLC cg
THETA XDDL	Angular acceleration about X axis, VLC cg
THETA YDDL	Angular acceleration about Y axis, VLC cg
THETA ZDDL	Angular acceleration about Z axis, VLC cg

- b. The following parameters were obtained from the three longitudinal accelerometers (vibration sensors on the Orbiter Bus)

Number	Description
THETA XDDB	Angular acceleration about X axis, top face of Bus
THETA YDDB	Angular acceleration about Y axis, top face of Bus
ZDDB	Z axis acceleration of Bus (average of 3 measurements)

- Notes:
- o VLC = Viking Lander Capsule
 - o VLCA = Viking Lander Capsule Adapter
 - o All transformed data was obtained with the use of a special filter set which held phase error between channels 9 through 18 to less than one degree.

TABLE 5. MATRIX OF TIME HISTORY PLOTS, TC-1

Event	Time of Event	Vibration & Microphone	Strain & Vibration	Forces & Moments	VLC cg Acceleration	Bus Acceleration
Stage 0 Ignition/Lift Off	13:48:01.6	2-3	4	5	6	7
Max Q	13:48:45	8-10	11-12	13-14	15-16	17-18
FBR Release	13:49:41.4	19	20	21	22	23
Stage 1 Burn Out	13:52:24.5	24	25	26	27	28

FIGURE NUMBERS

TABLE 6. MATRIX OF TIME HISTORY PLOTS, TC-4

Event	Time of Event	Vibration & Microphone	Strain & Vibration	Forces & Moments	VLC cg Acceleration	Bus Acceleration
Stage 0 Ignition/Lift Off	21:22:00	29	30	31	32	33
Max Q	21:22:38	34-35	36-37	38-39	40-41	42-43
FBR Release	21:23:40.2	44				
Stage 1 Ignition-Jettison SRM	21:23:50.6	45	46	47-48	49-50	51-52
FLMN 1	21:25:50		53	54	55	56
FLMN 2	21:26:10		57	58	59	60
Stage 1 Burn Out	21:26:19.5		61	62	63	64
Jettison Shroud	21:26:31.9	65	-	66	67	68
Stage 2 Burnout	21:29:47.6		69	70	71	72
Titan/Centaur Separation	21:29:57	73				
MES 1	21:30:05.5		74	75	76	77
Centaur Burn 1	21:30:13		78	79	80	81
Centaur Burn 1	21:30:20		82	83	84	85
MECO 1	21:32:11.3		86	87	88	89
MES 2	21:47:31.2		90	91	92	93
MECO 2	21:52:46.3	94	94	-	96	97

FIGURE NUMBERS

TABLE 7. MATRIX OF TIME HISTORY PLOTS, TC-3

Event	Time of Event	Vibration & Microphone	Strain & Vibration	Forces & Moments	VLC cg Acceleration	Bus Acceleration
Stage 0 Ignition/ Lift Off	18:39:00	98-99	100	101	102	103
Max Q	18:39:42	104-106	107	108-109	110-111	112-113
FBR Release	18:40:40	114	-	-	-	-
Stage 1 Ignition	18:40:51.6	115	116	117	118	119
Jettison SRM	18:41:03	120	121	122	123	124
FLMN-1	18:41:35	-	125	126	127	128
FLMN-2	18:41:50	-	129	130	131	132
FLMN-3	18:42:13	-	133	134	135	136
FLMN-4	18:42:57	-	137	138	139	140
Stage 1 Burnout	18:43:20.9	141	142	143	144	145
Jettison Shroud	18:43:31.6	146	147	148	149	150
Stage 2 Burnout	18:46:48.3	151	152	153	154	155
Titan Centaur Separation	18:46:53.3	156	-	-	-	-
MES 1	18:47:04.8	157	158	159	160	161
Centaur Burn 1	18:47:13	-	162-163	164-165	-66-167	168-169
MECO 1	18:49:13.1	170	171	172	173	174
MES 2	19:07:26.8	175	176	177	178	179
MECO 2	19:12:27.7	180	181	182	183	-

FIGURE NUMBERS

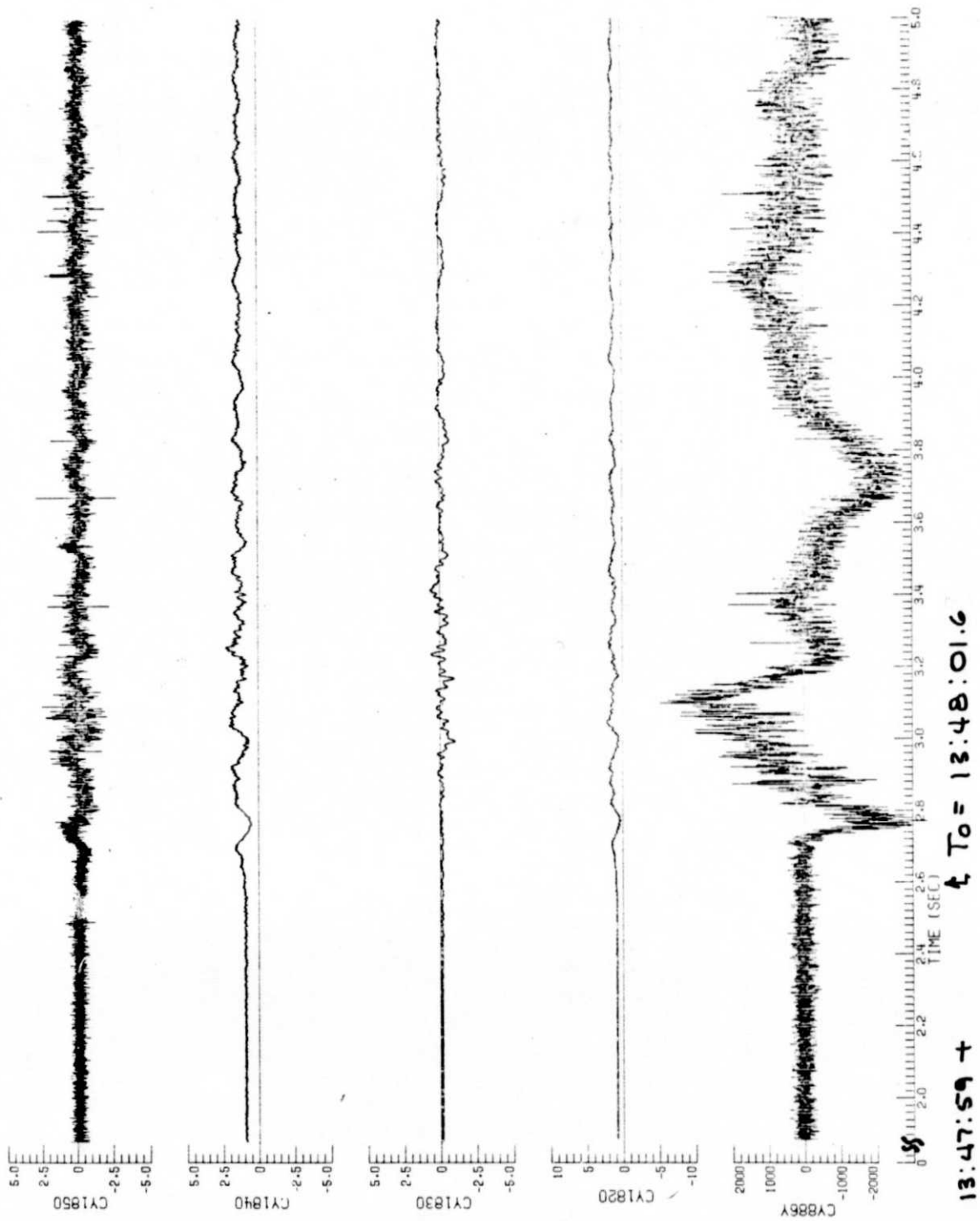
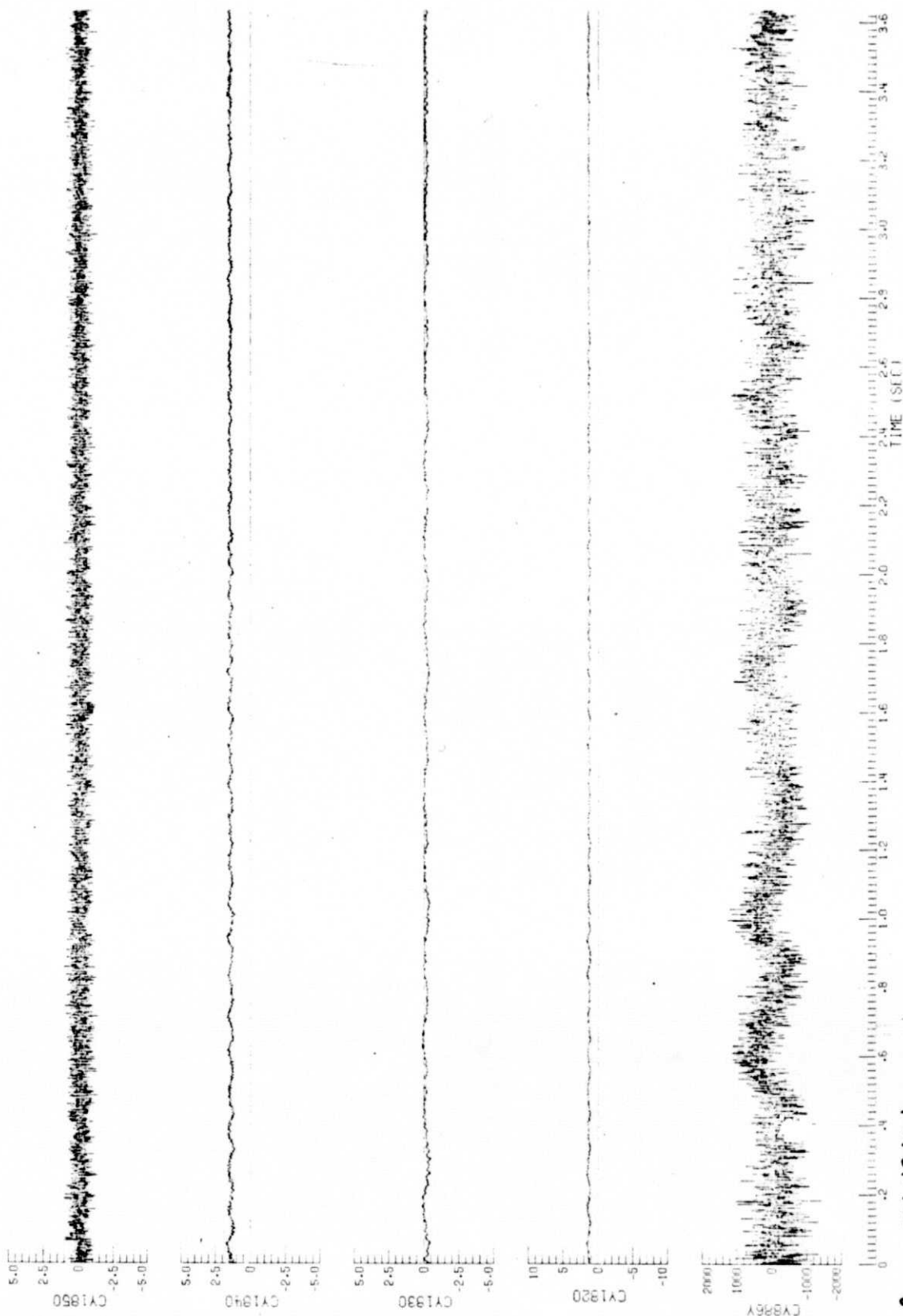


Figure 2. TC-1 Stage 0 Ignition - Vib. & Mic - Part 1 - 8192 SPS



from 13:48:04

ORIGINAL PAGE IS
OF POOR QUALITY

Figure 3 - TC-1 Stage 0 Ignition, Vib. & Mic- Part 2 - 8192

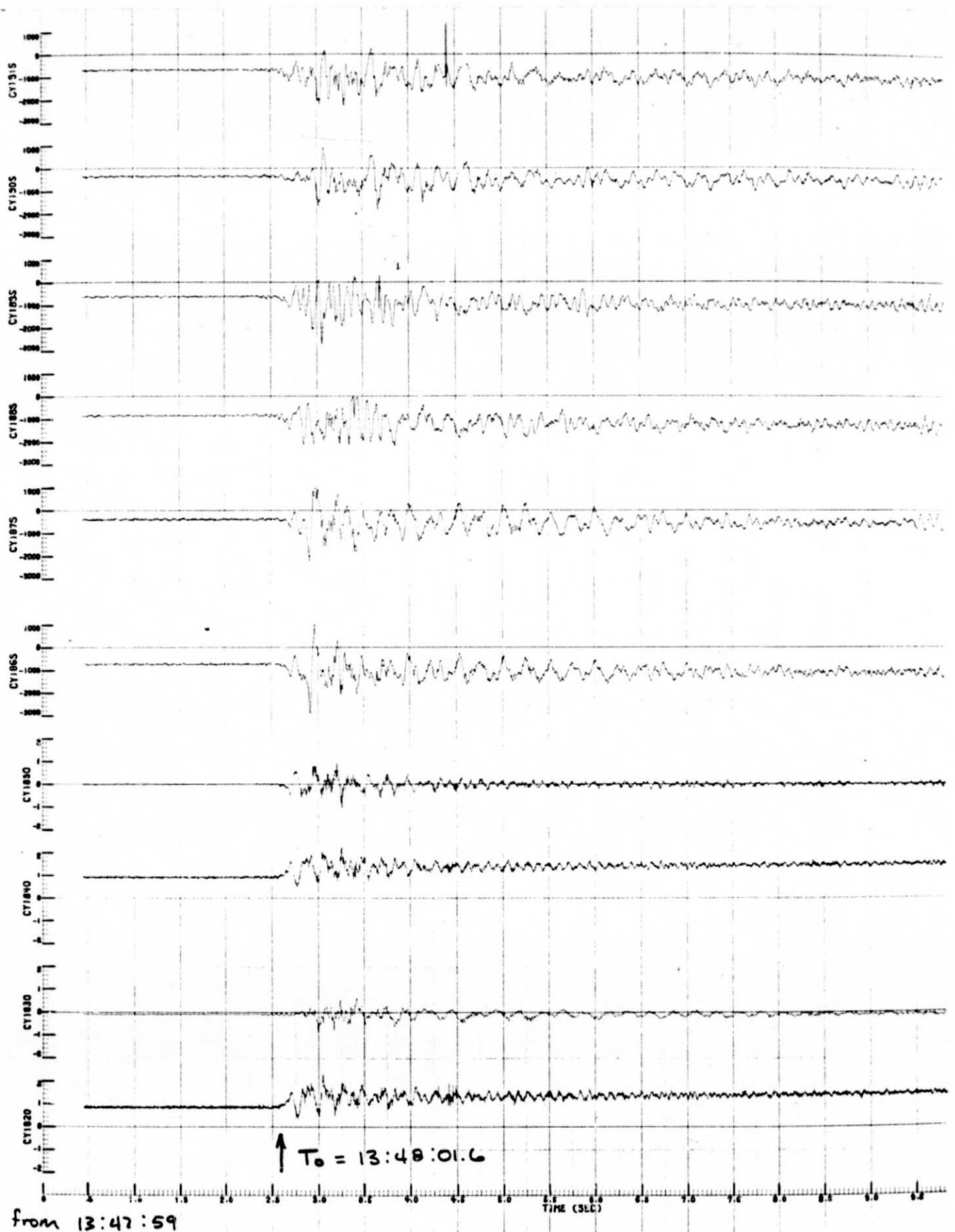


Figure 4. TC-1 Stage 0 Ignition - Strain & Vib. - 1024 SPS

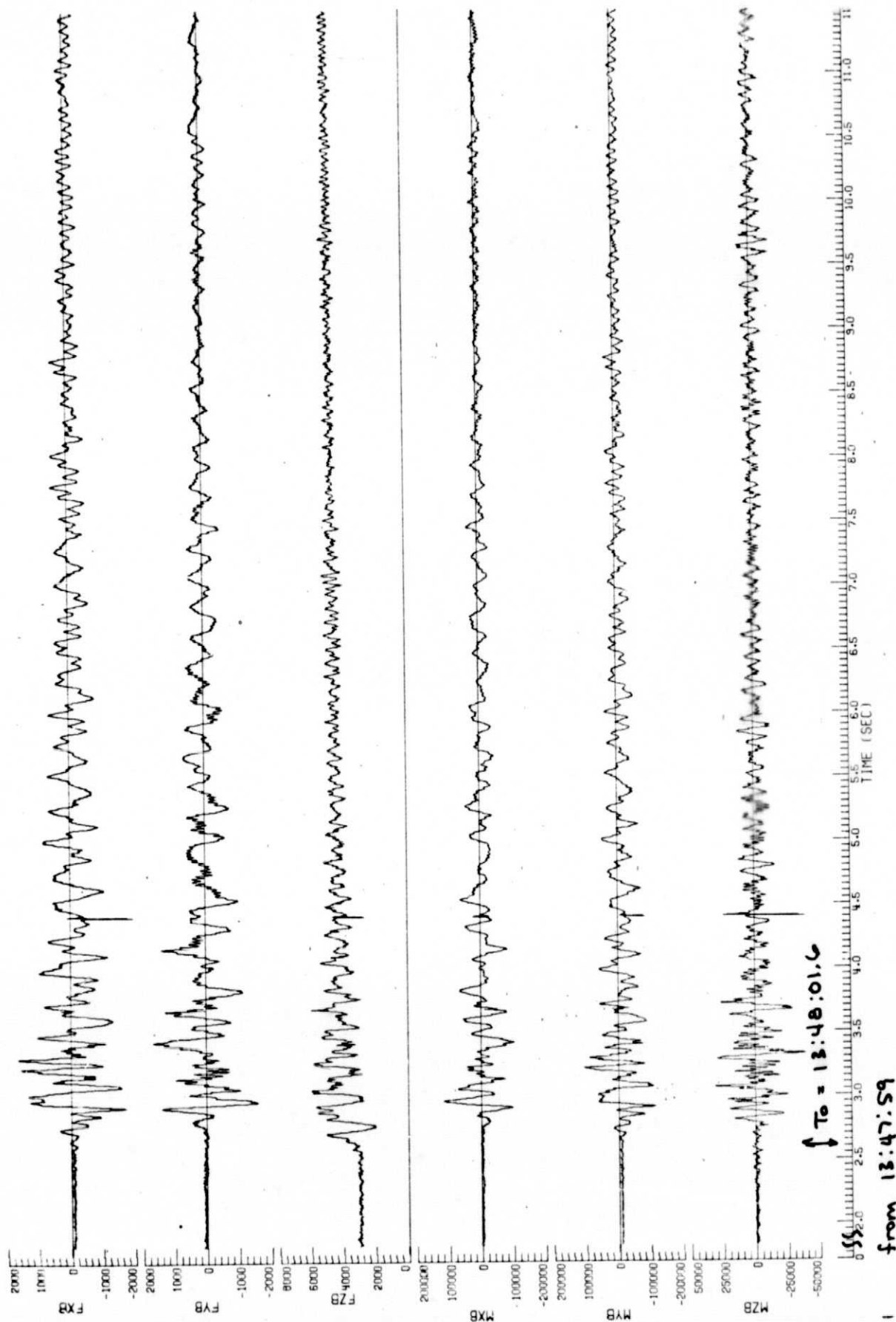


Figure 5. TC-1 Stage 0 Ignition - Forces & Moments - 1024 SPS

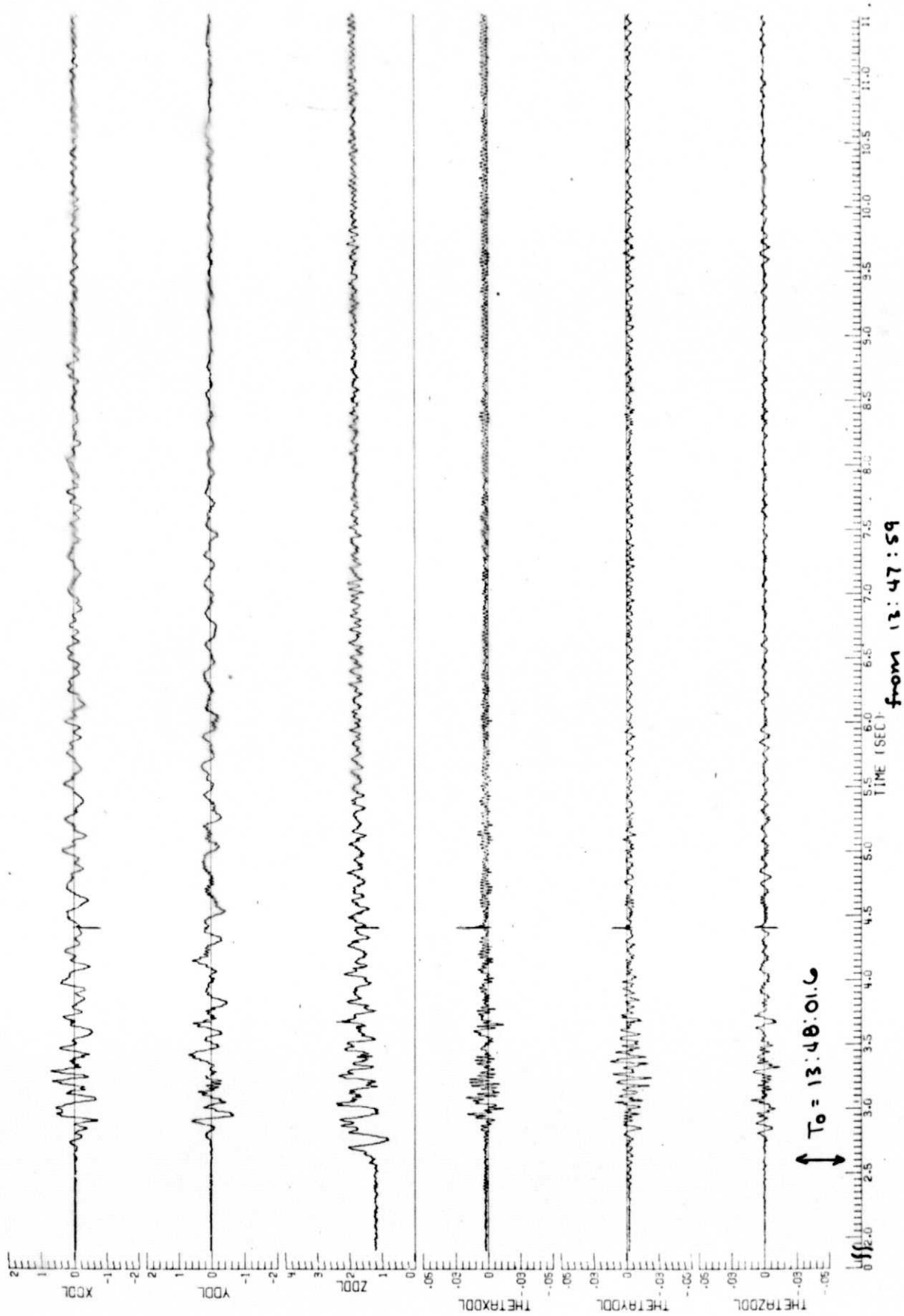


Figure 6. TC-1 Stage 0 Ignition - VLC cg Accelerations - 1024 sps

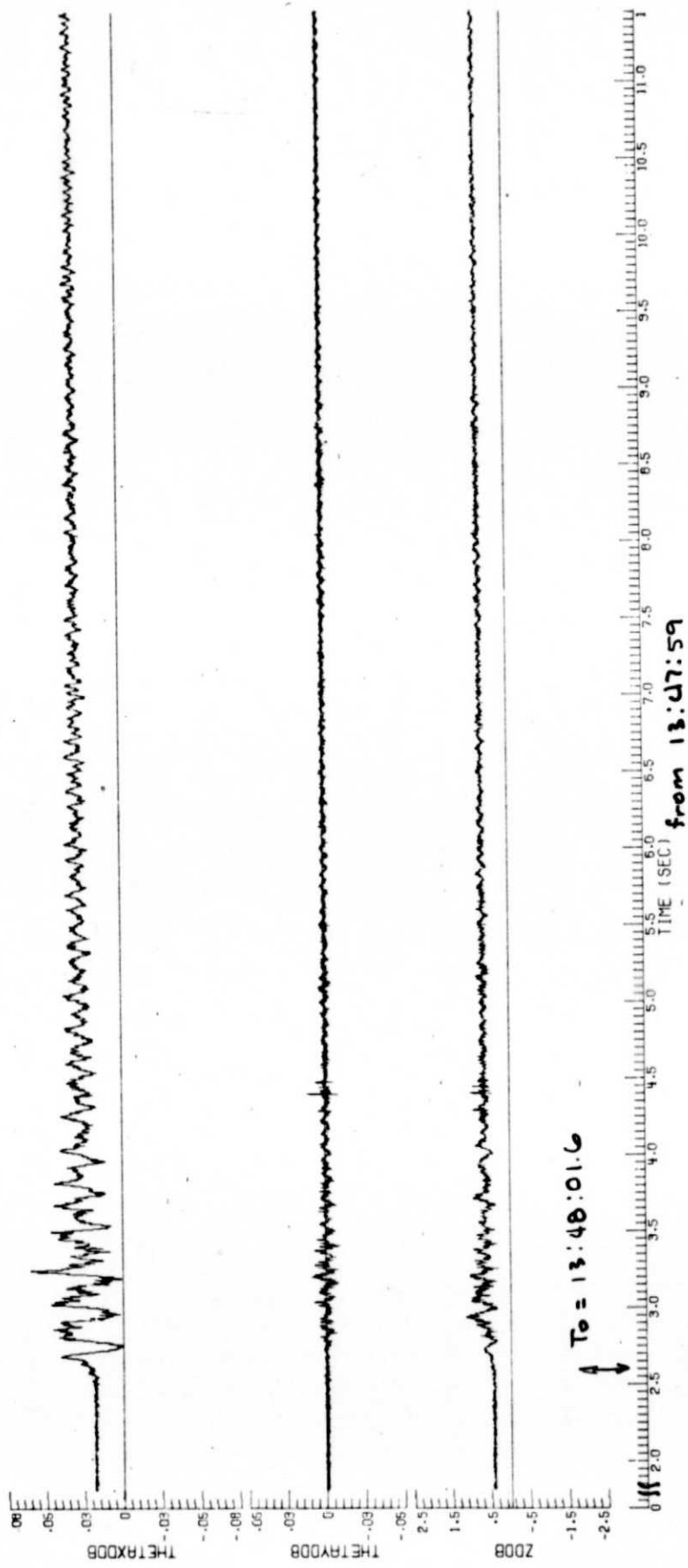


Figure 7. TC-1 Stage 0 Ignition - Bus Accel. - 1024 SPS

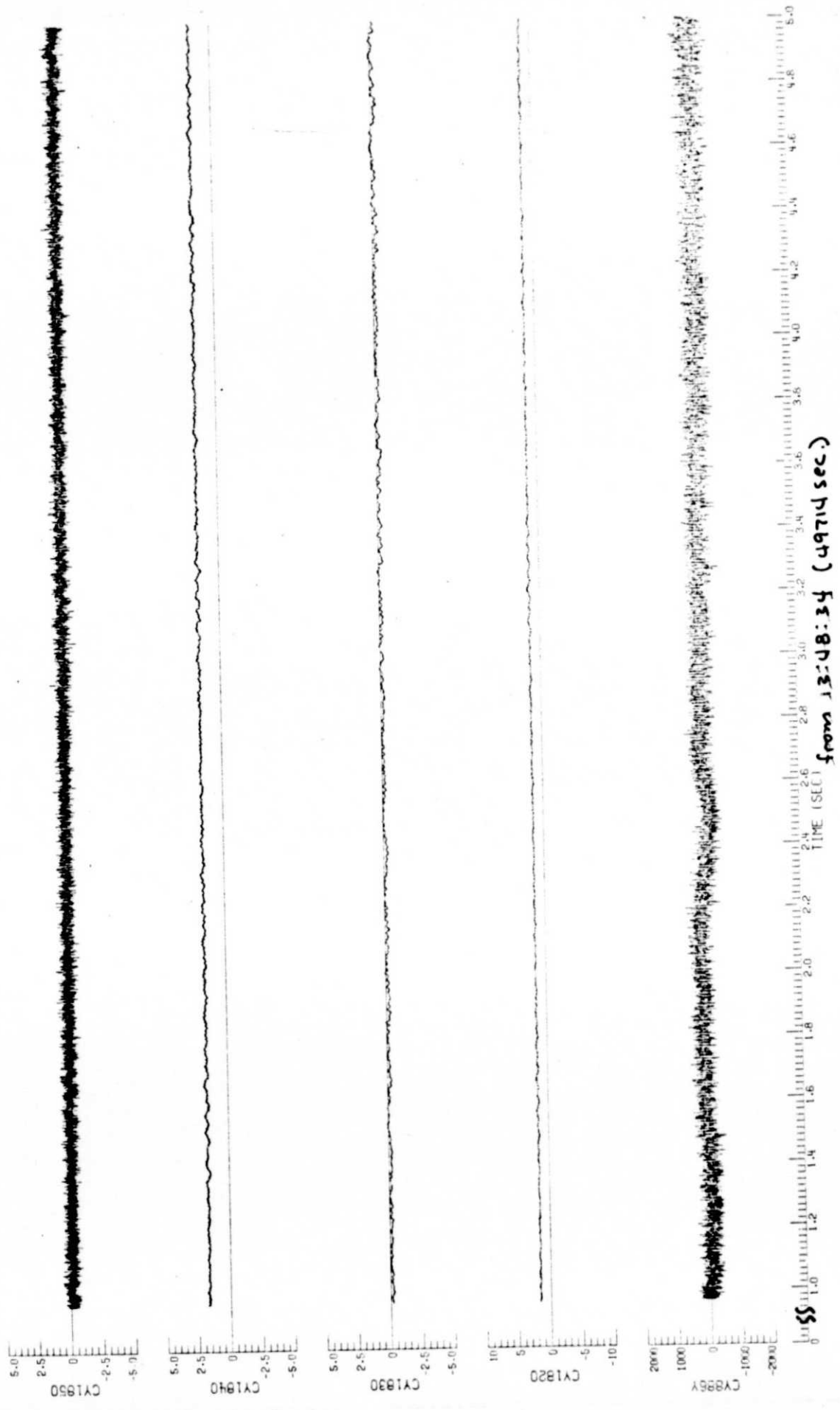
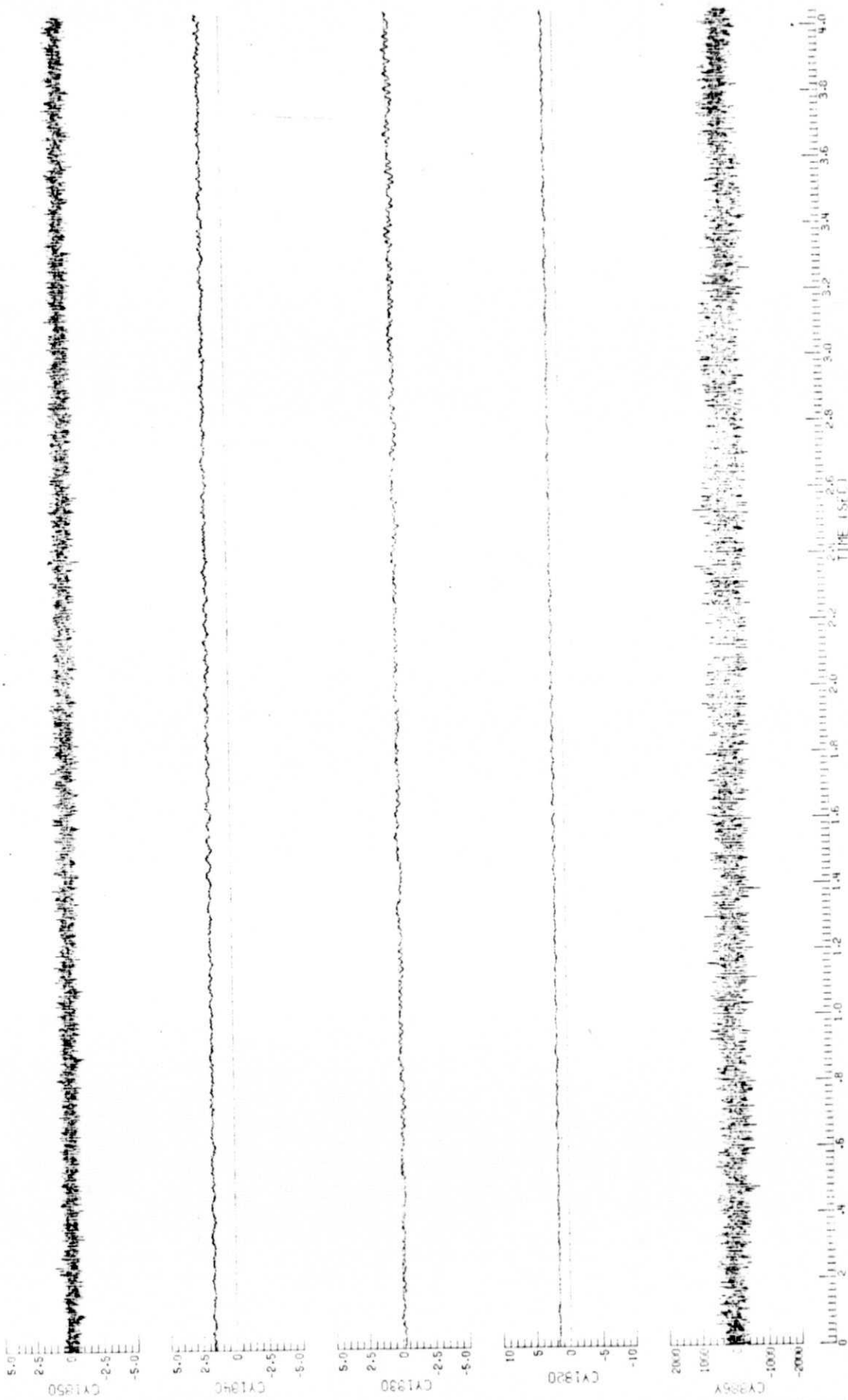
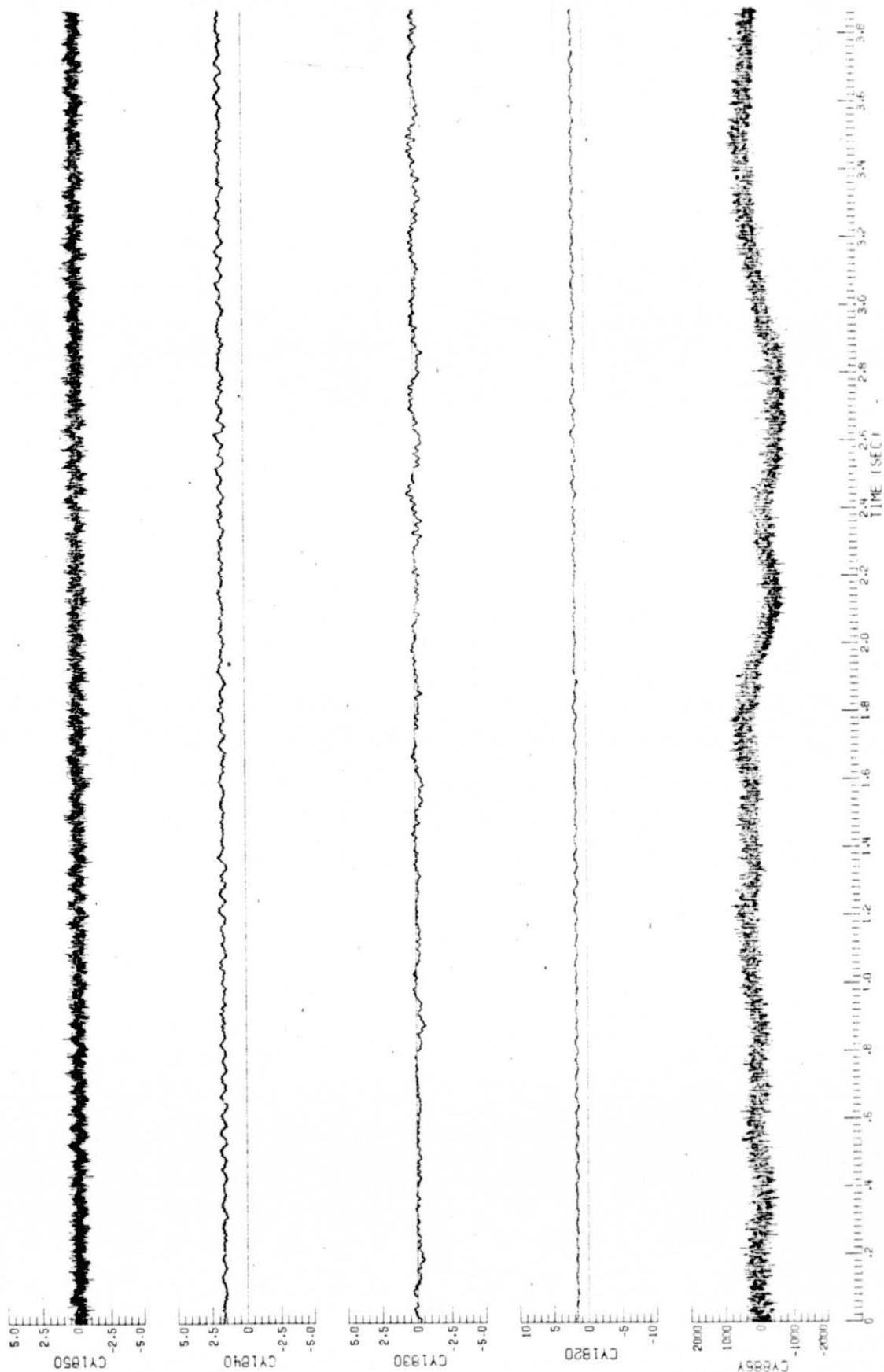


Figure 8. TC-1 Max Q - Part 1 - Vib. & Mic. - 8192 SPS



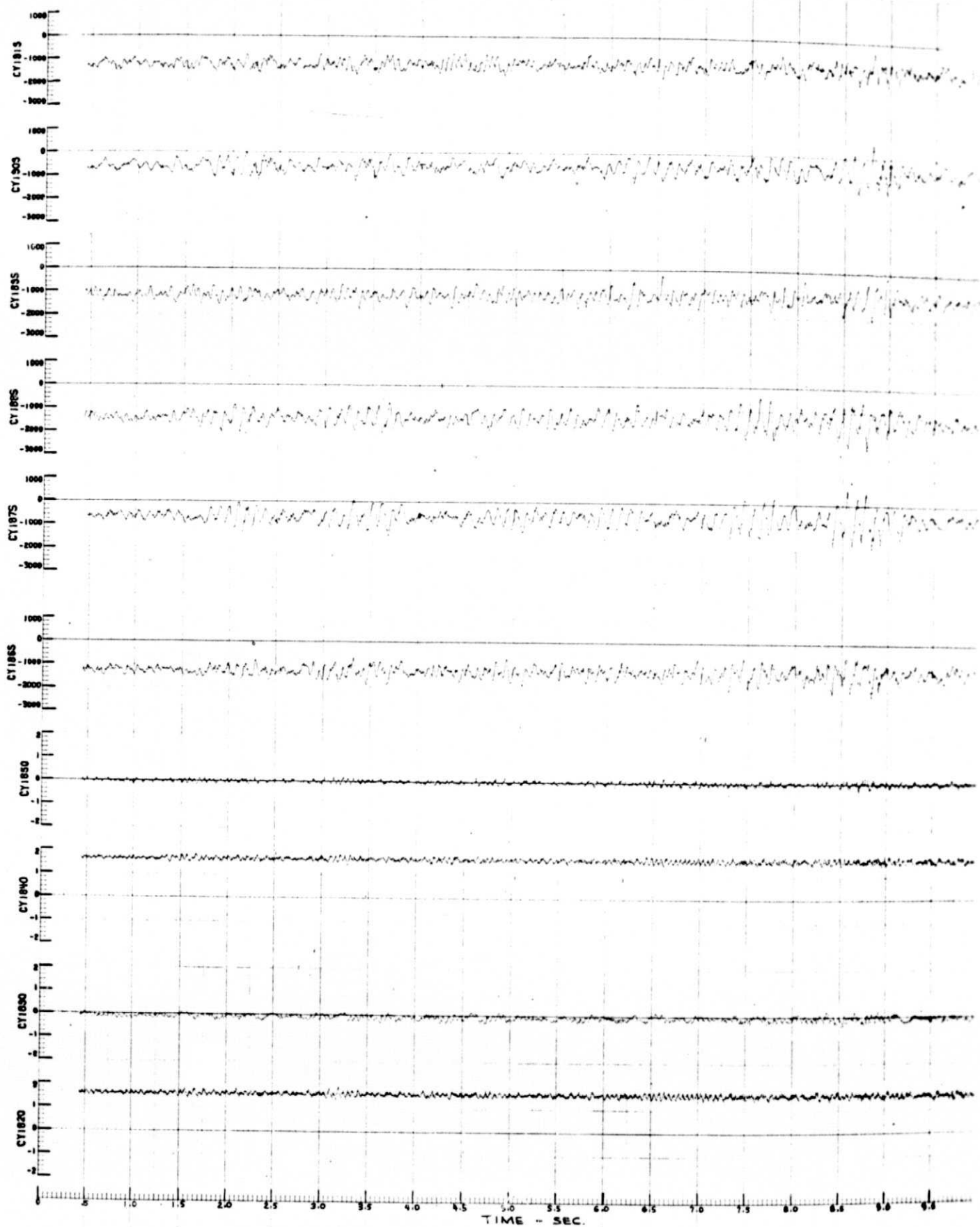
0 = 13:48:39 = 49719 Sec.

Figure 9. TC-1 Max Q - Part 2 - Vib. & Mic. - 8192 SPS



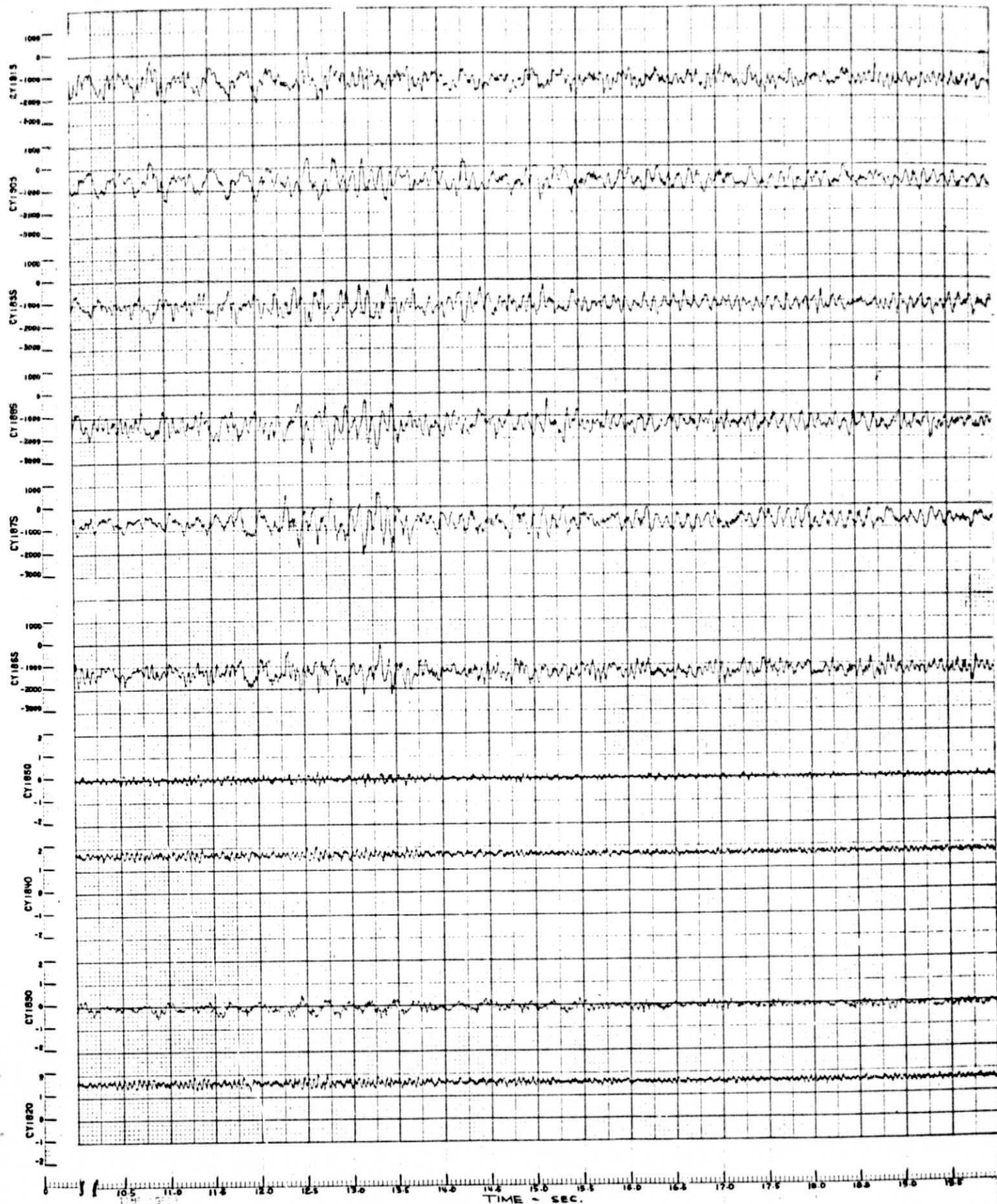
0 = 13:48:44 = 49724 Sec.

Figure 10. TC-1 Max Q - Part 3 - Vib. & Mic. - 8192 SPS



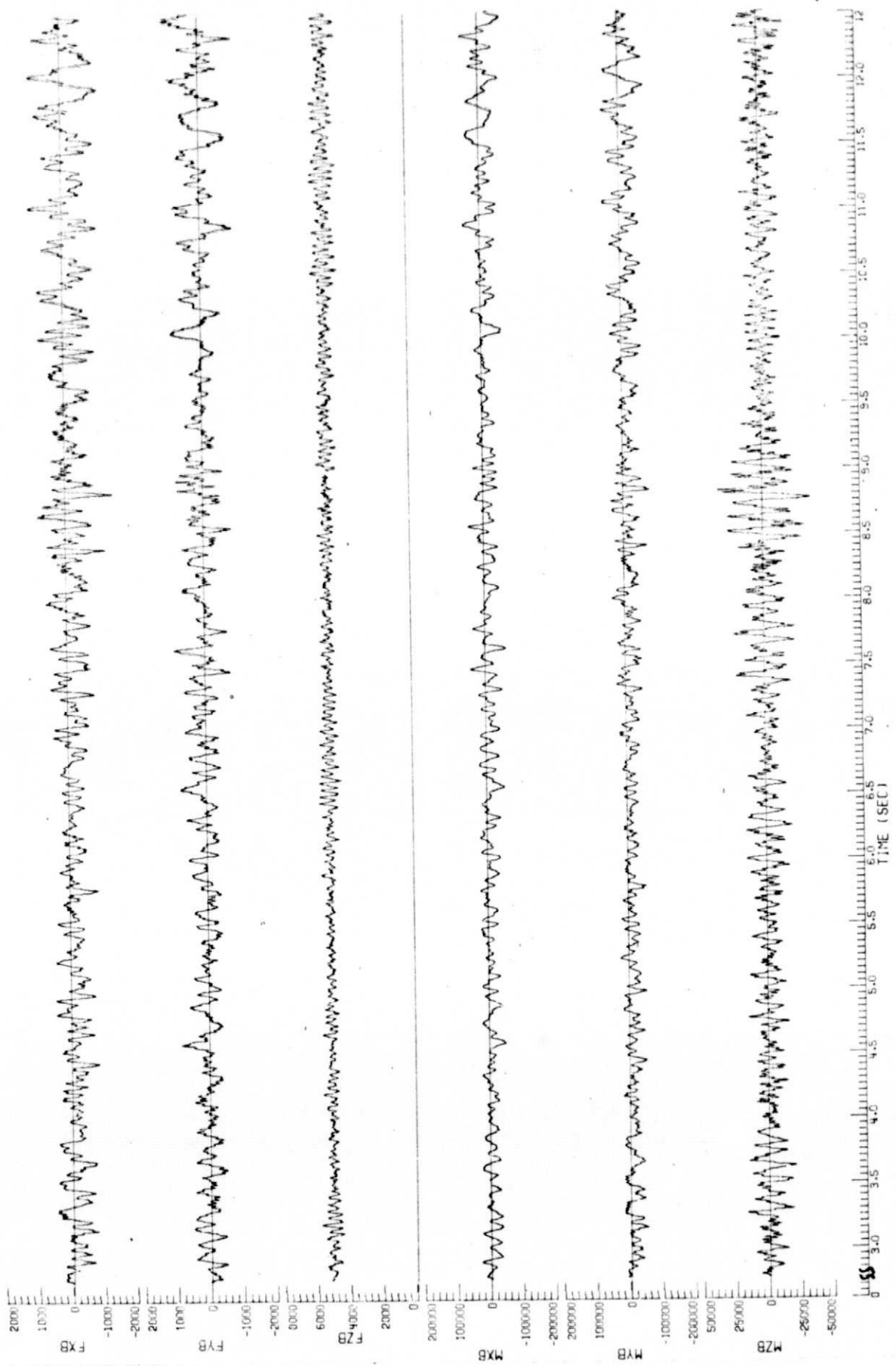
0 = 13:48:34 = 49714 Sec.

Figure 11. TC-1 Max Q Strain & Vib - Part 1 - 1024 SPS



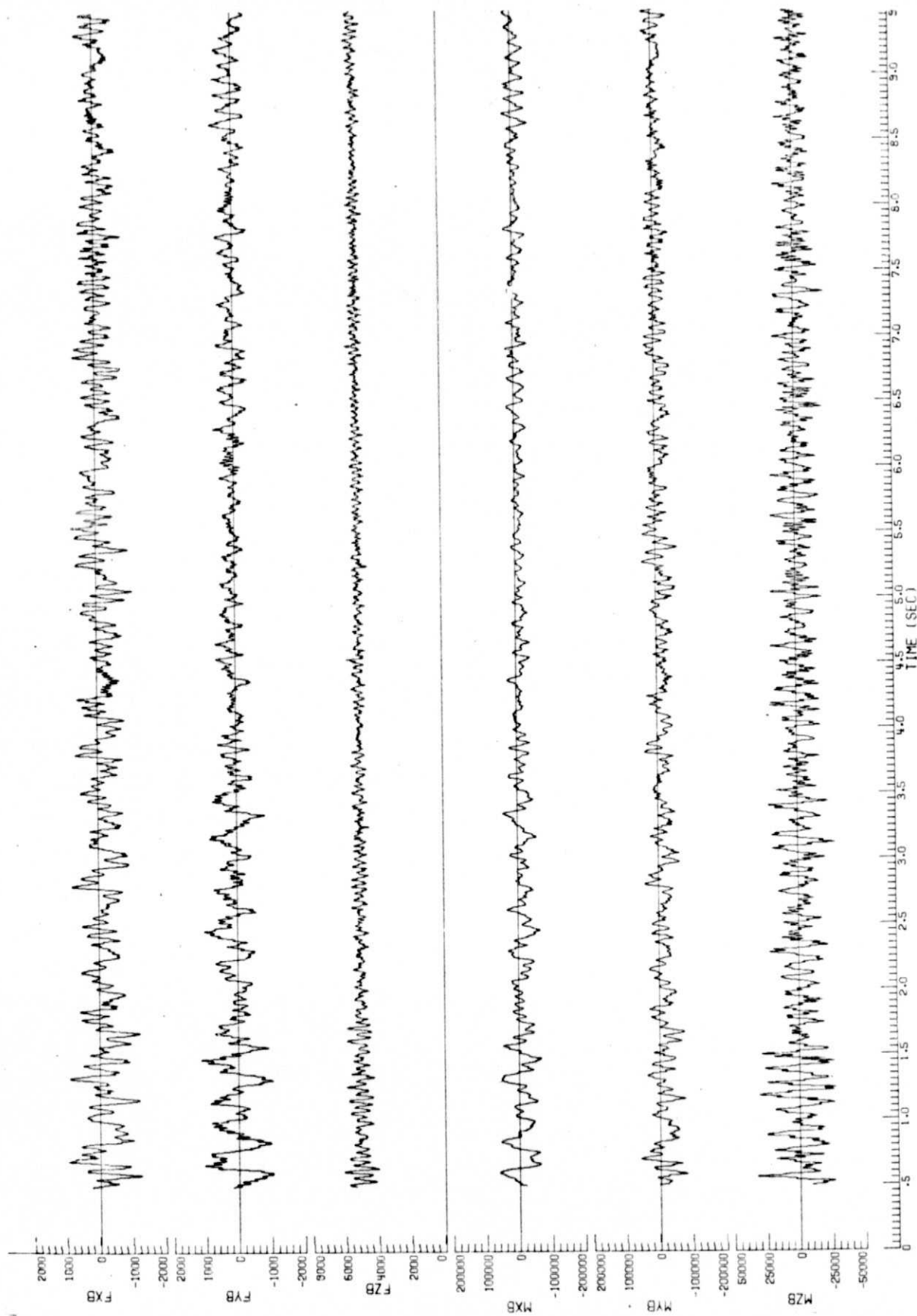
0 = 13:48:34 = 49714

Figure 12. TC-1 Max Q Strain & Vib Part 2 - 1024 SPS



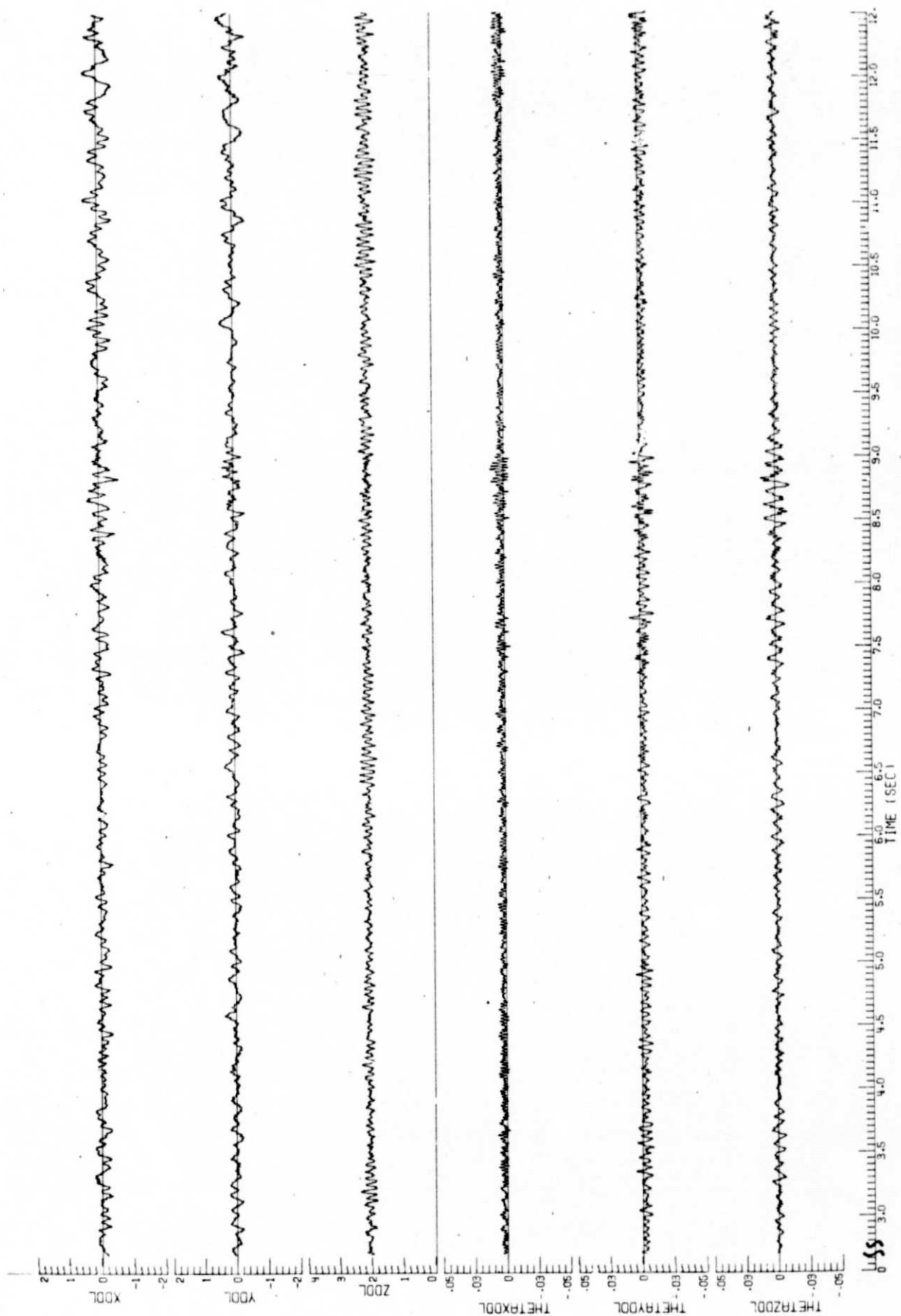
0 = 13:48:34 = 49714 Sec.

Figure 13. TC-1 Max Q - Forces & Moments - Part 1 - 1024 SPS



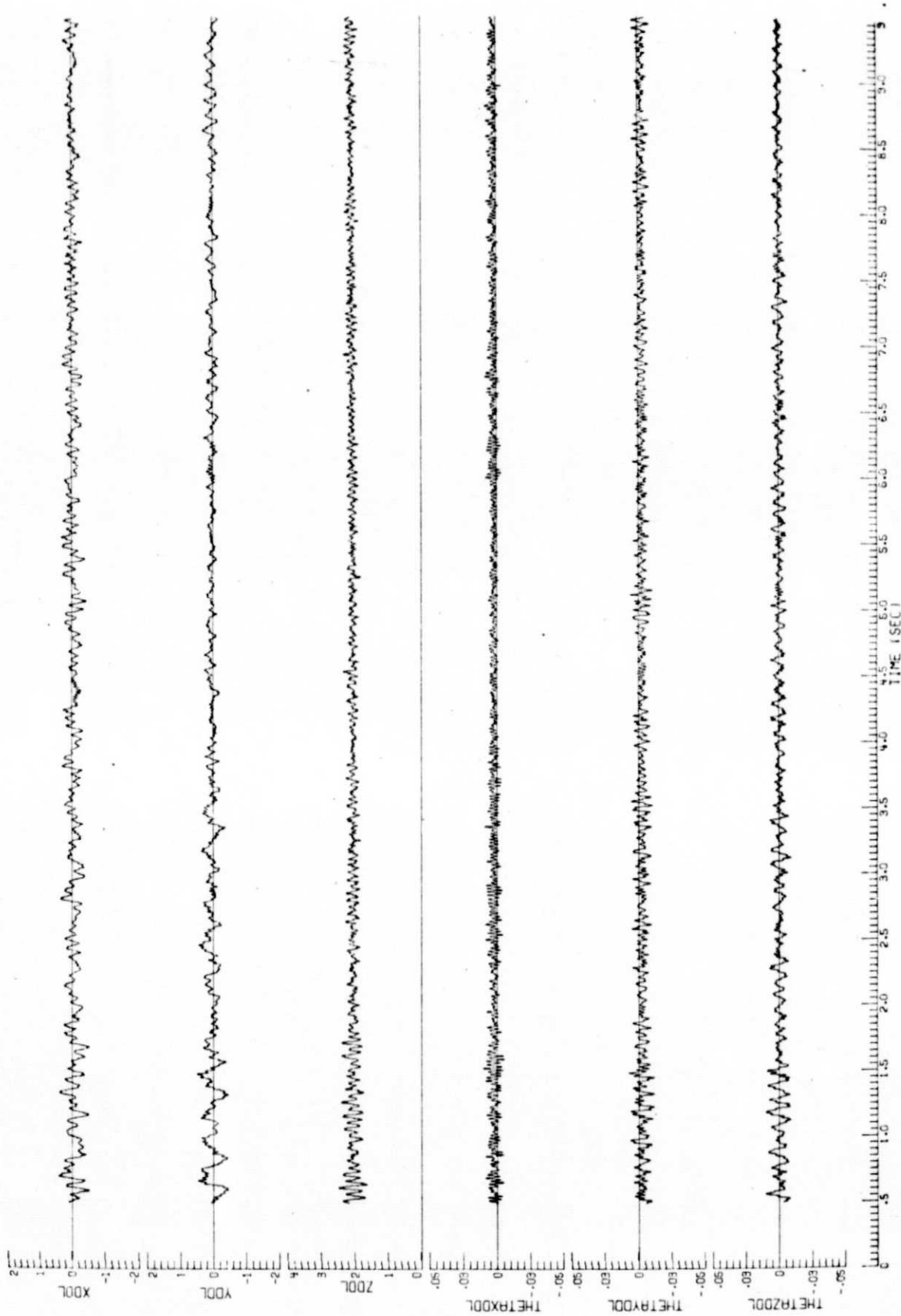
0 = 13:48:46 = 49726 Sec.

Figure 14. TC-1 Max Q - Forces & Moments - Part 2 - 1024 SPS



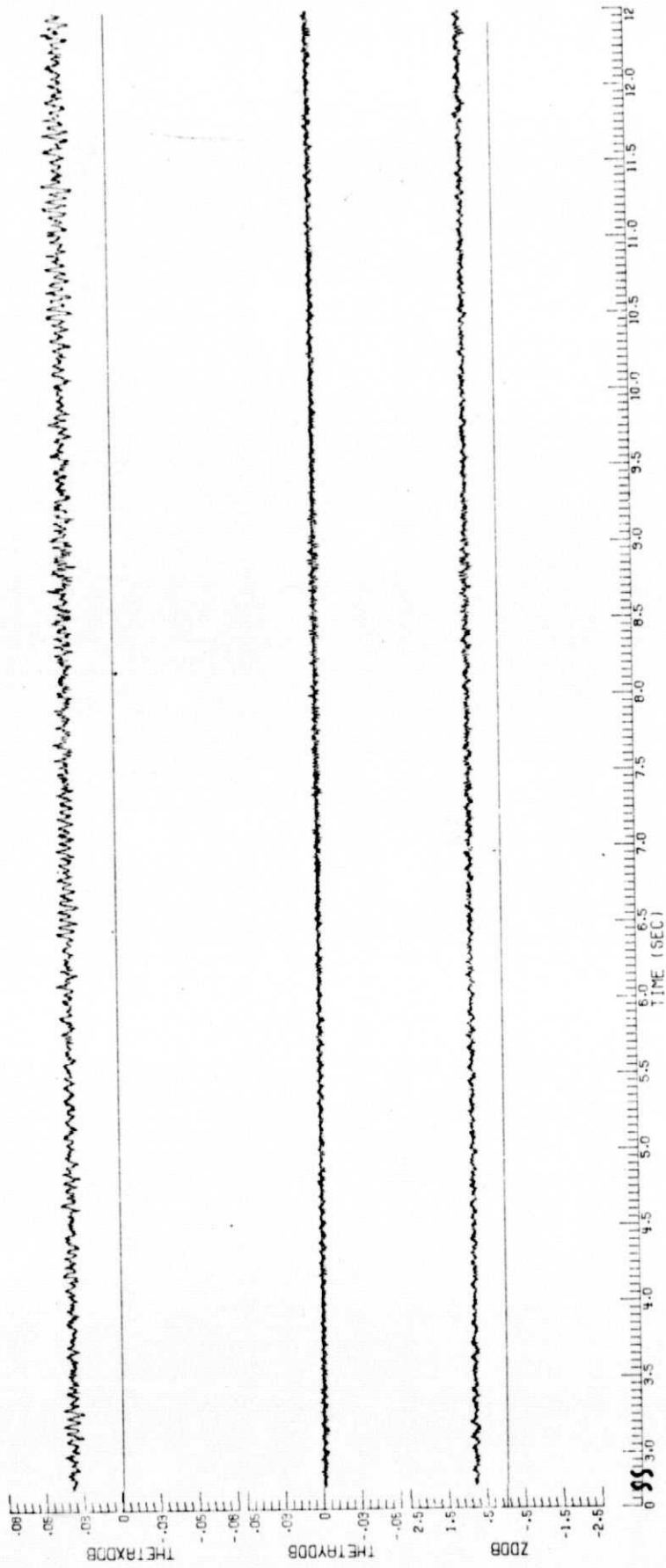
0 = 13:48:34 = 49714 Sec.

Figure 15. TC-1 Max Q - VLC cg Accelerations - Part 1 - 1024 SPS



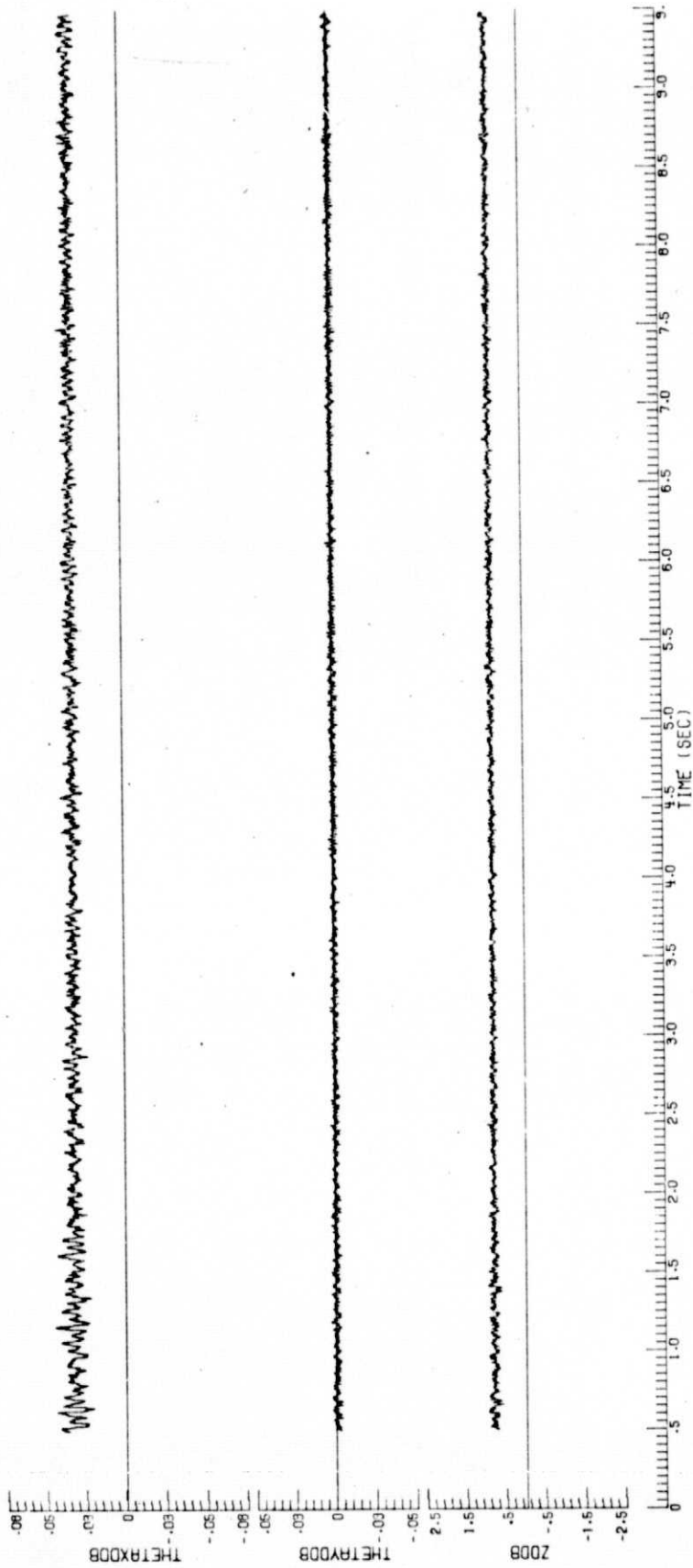
0 = 13:48:46 = 49726 Sec.

Figure 16. TC-1 Max Q - VLC cg Accelerations - Part 2 - 1024 SPS



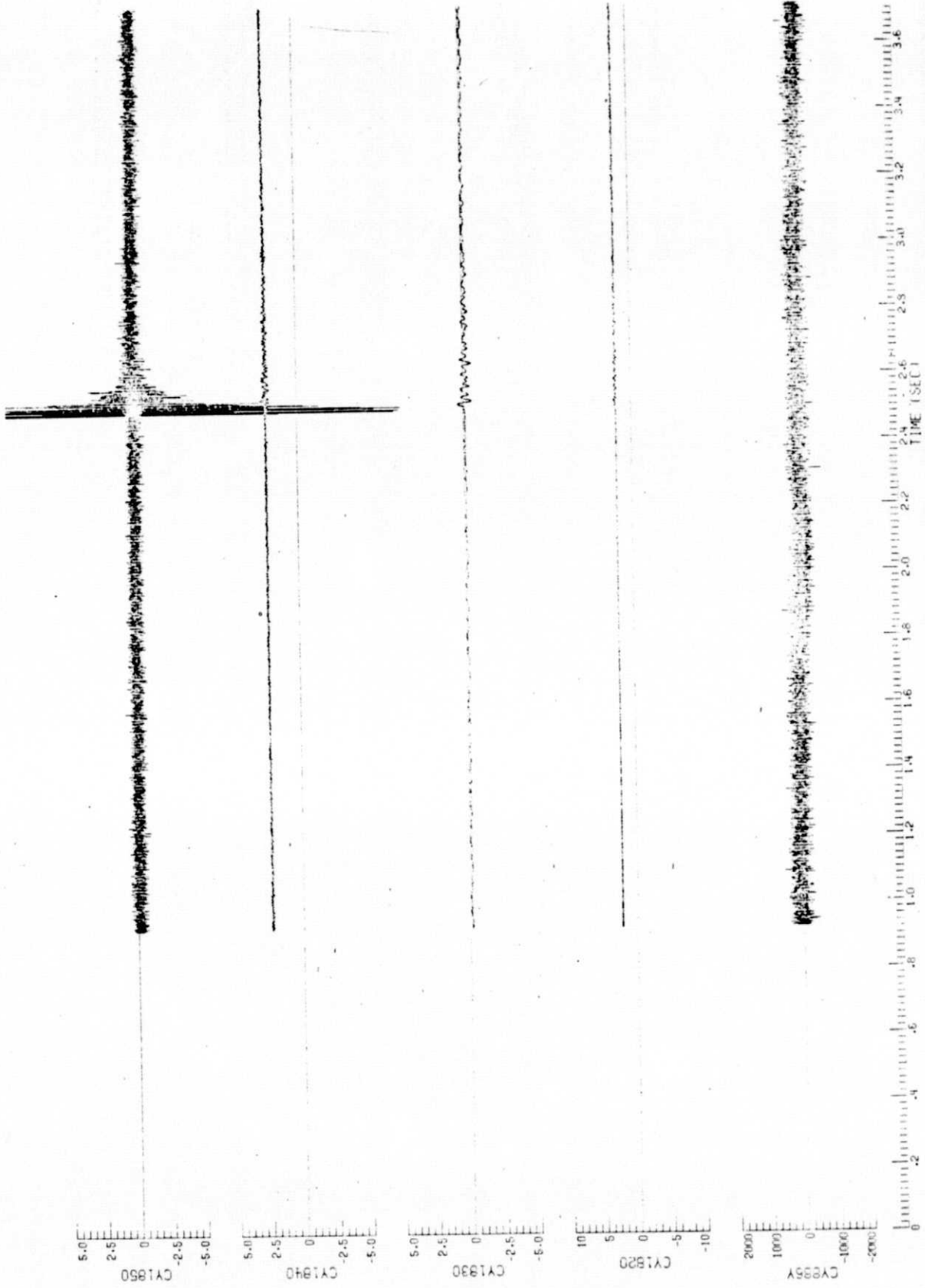
0 = 13:48:34 = 49714 Sec.

Figure 17. TC-1 Max Q Part 2 - Bus Accelerations - 1024 SPS



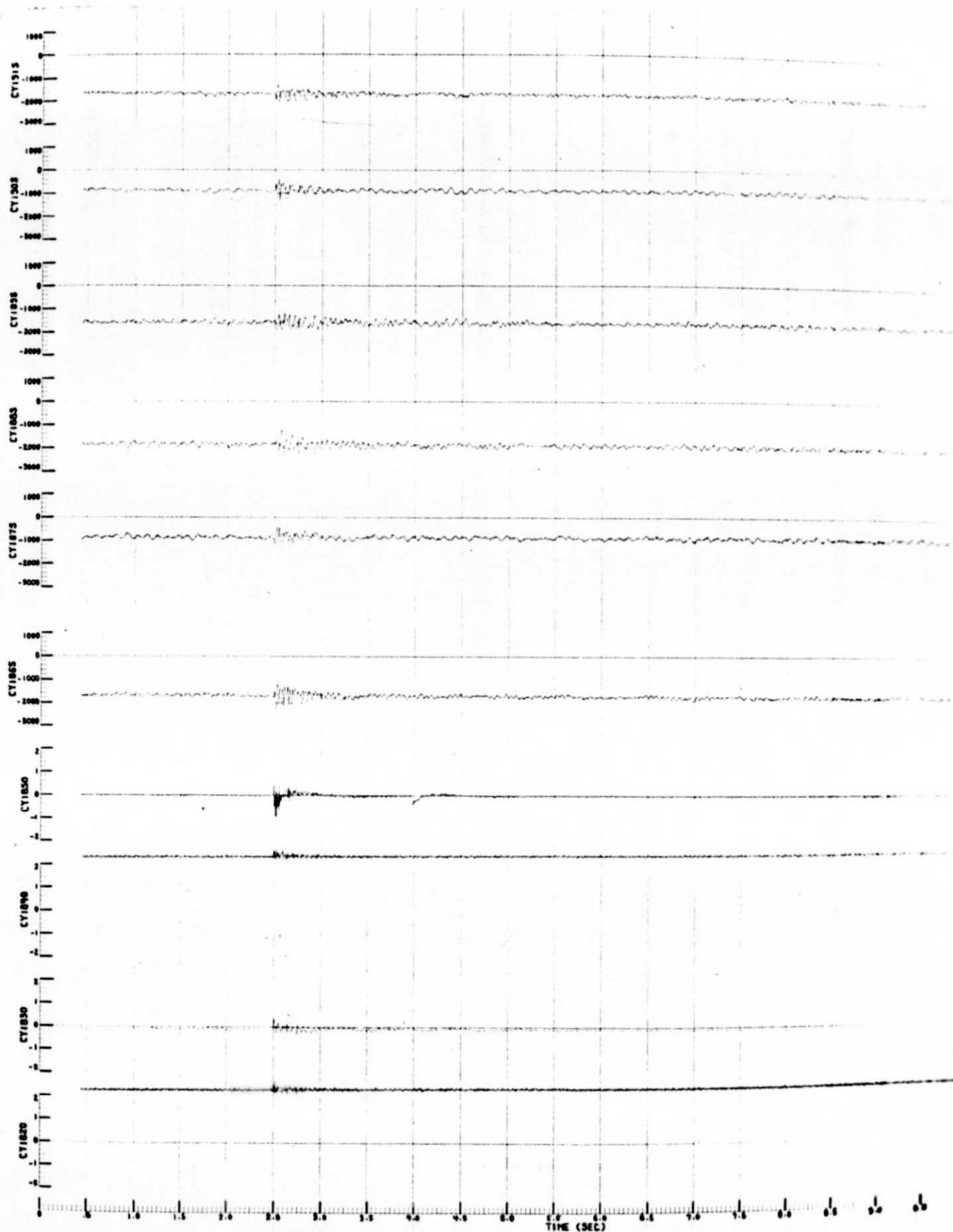
0 = 13:48:46 = 49726 Sec.

Figure 18. TC-1 Max Q Bus Accelerations - Part 2 - 1024 SPS



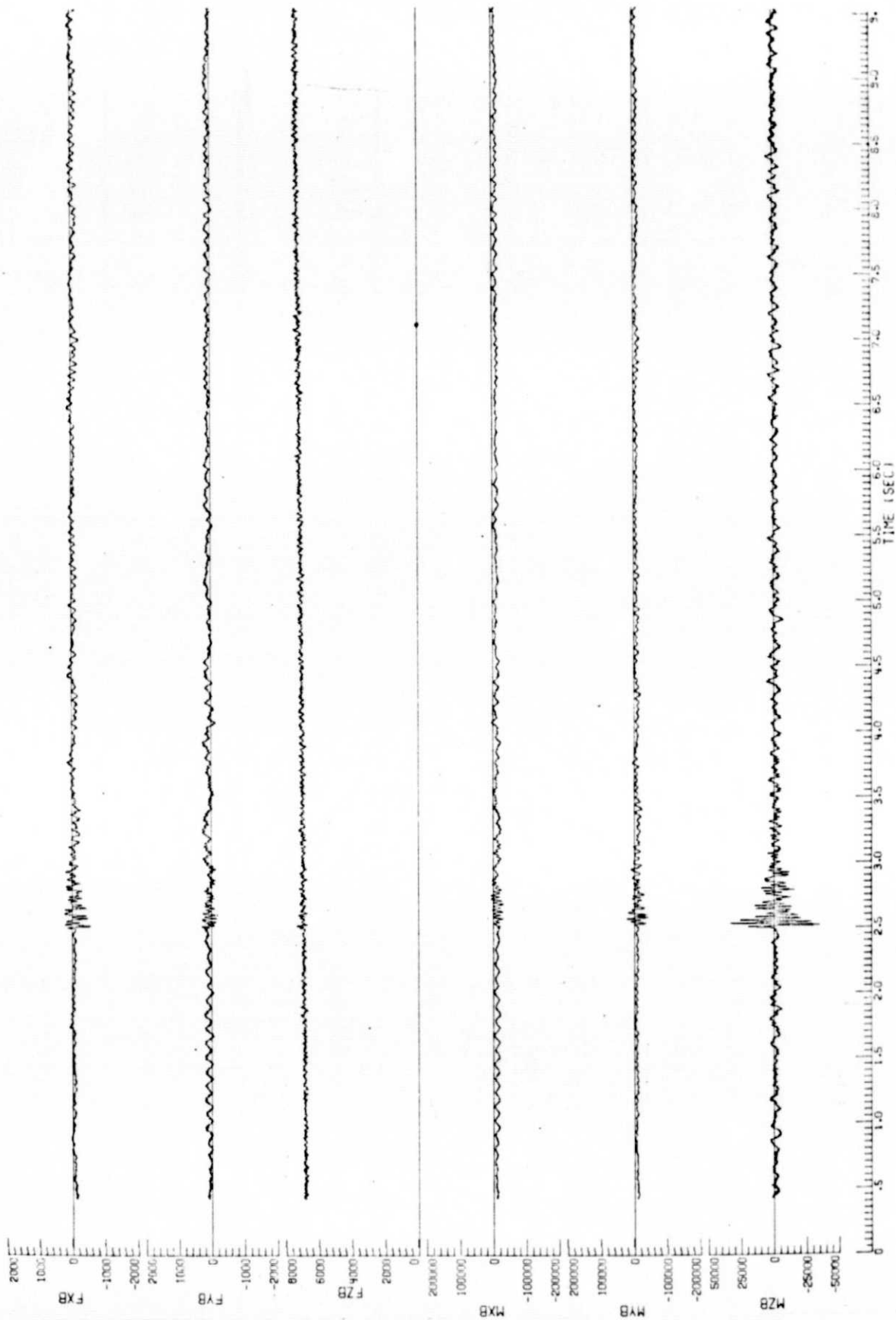
0 = 13:49:39 = 49779 Sec.

Figure 19. TC-1 FBR Release Vibration - 8192 SPS



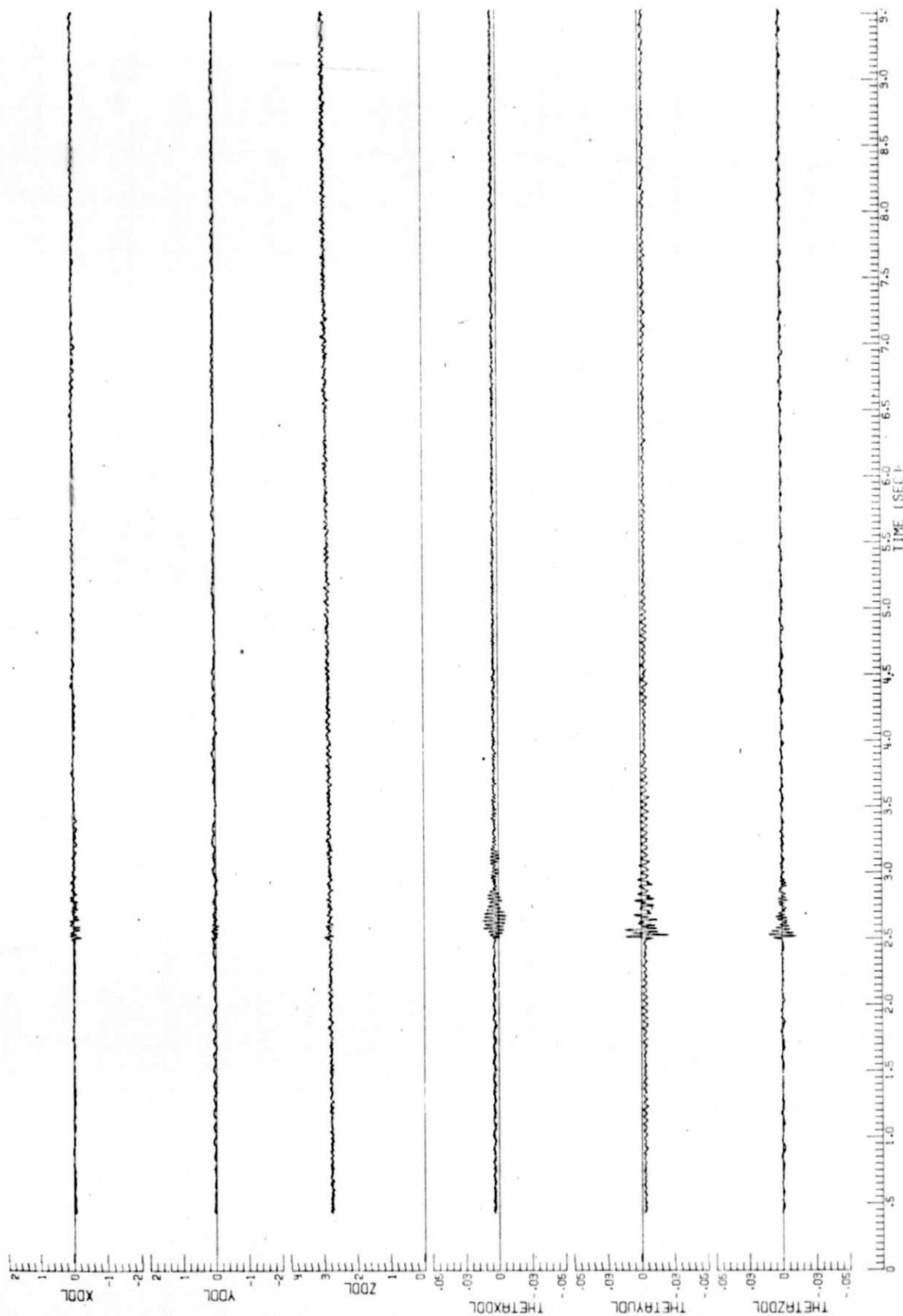
13:49:39 = 49779 Sec.

Figure 20. TC-1 FBR Release - Strain & Vib. - 1024 SPS



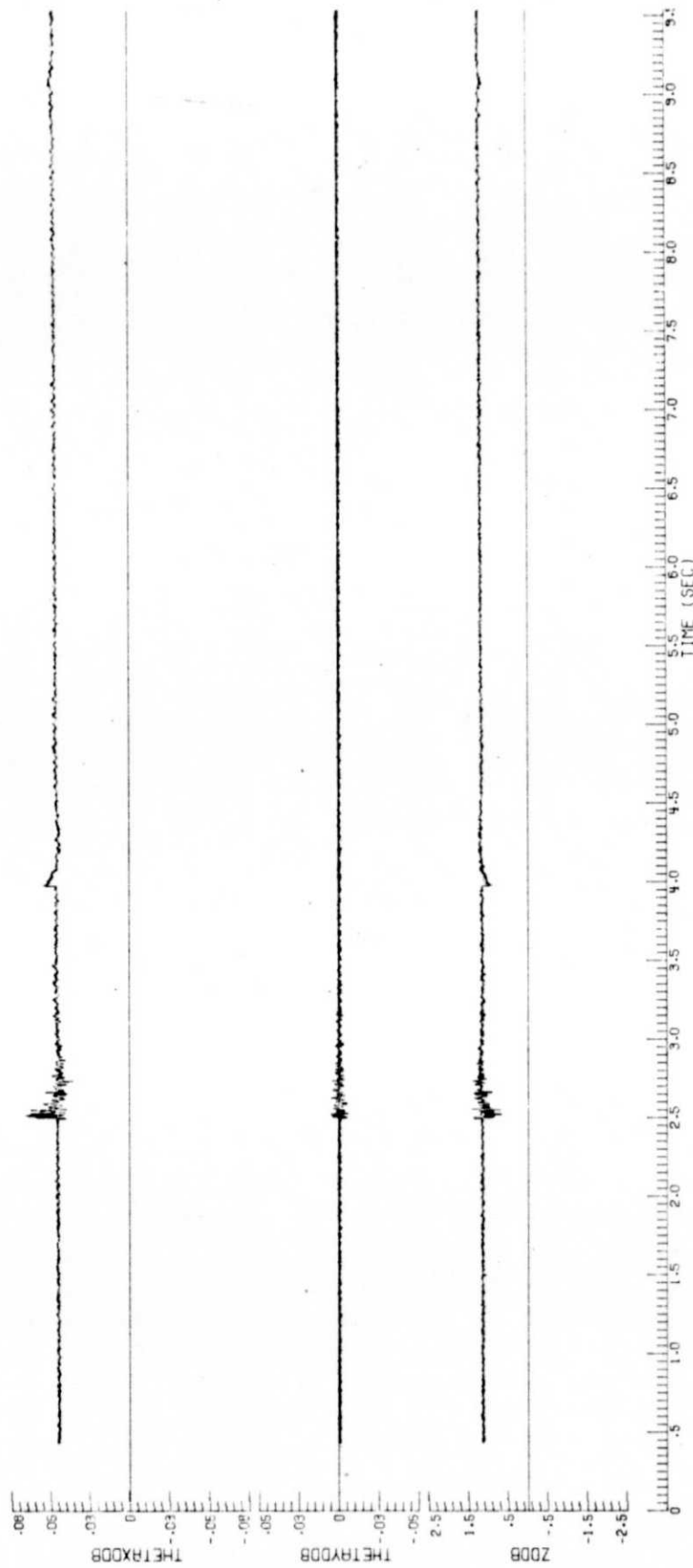
0 = 13:49:39 = 49779 Sec.

FIGURE 21. TC-1 FBR Release - Forces & Moments - 1024 SPS



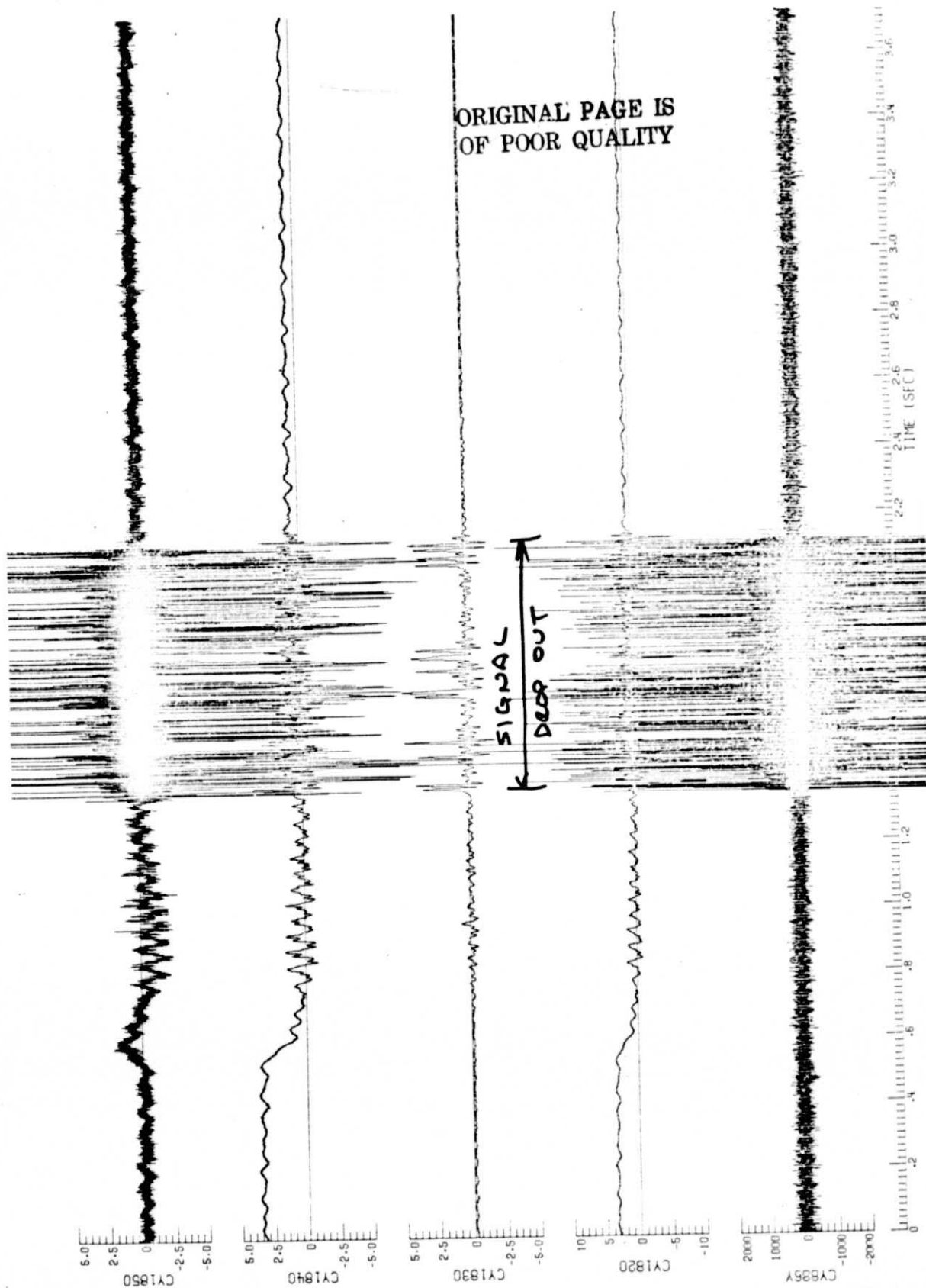
0 = 13:49:39 = 49779 Sec.

Figure 22. TC-1 FBR Release - VLC cg Accelerations - 1024 SPS



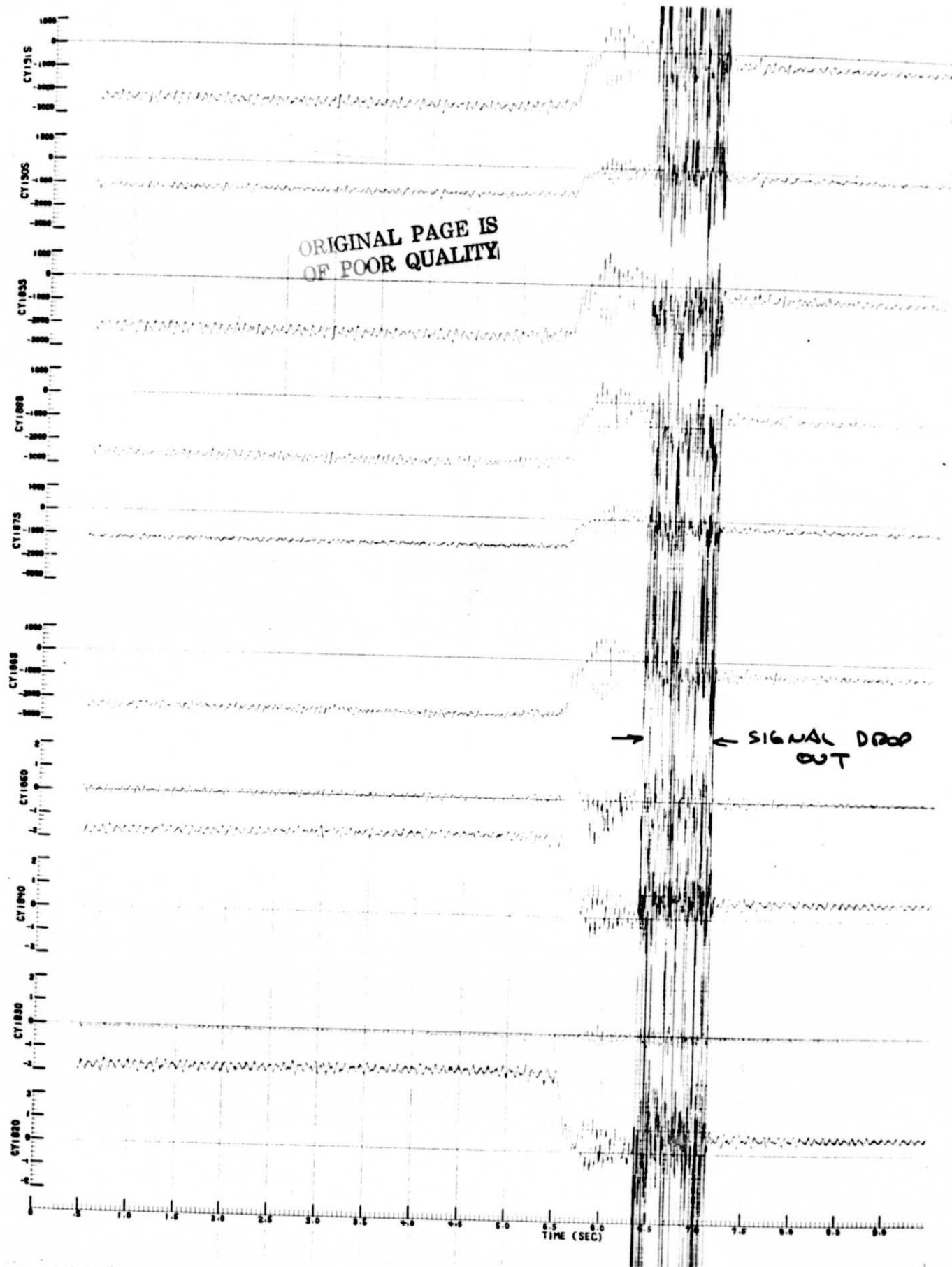
0 = 13:49:39 = 49779 Sec.

Figure 23. TC-1 FBR Release - Bus Accelerations - 1024 SPS



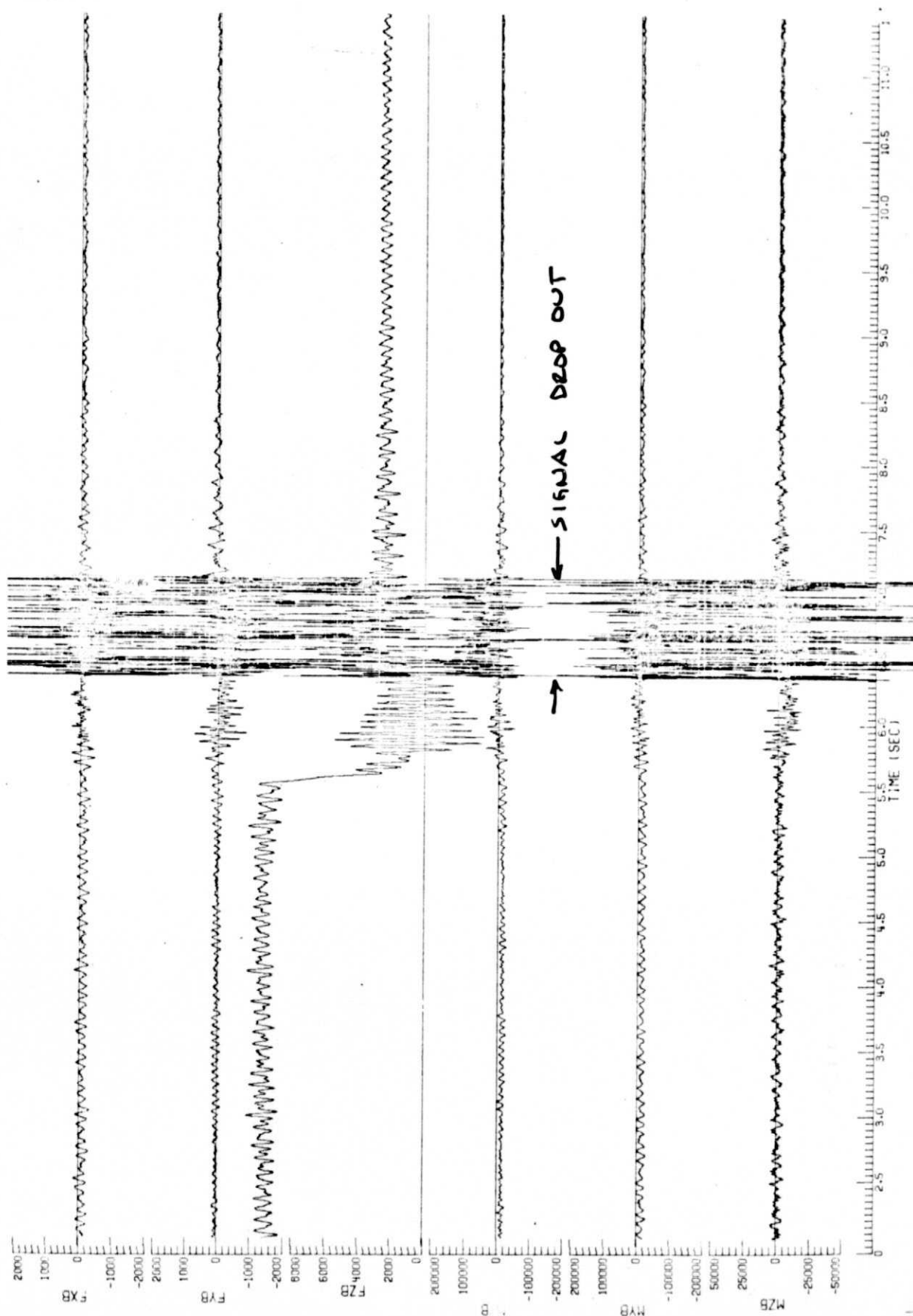
0 = 13:52:24 = 49944 Sec.

Figure 24. TC-1 Stage 1 Burn Out - Vib. - 8192 SPS



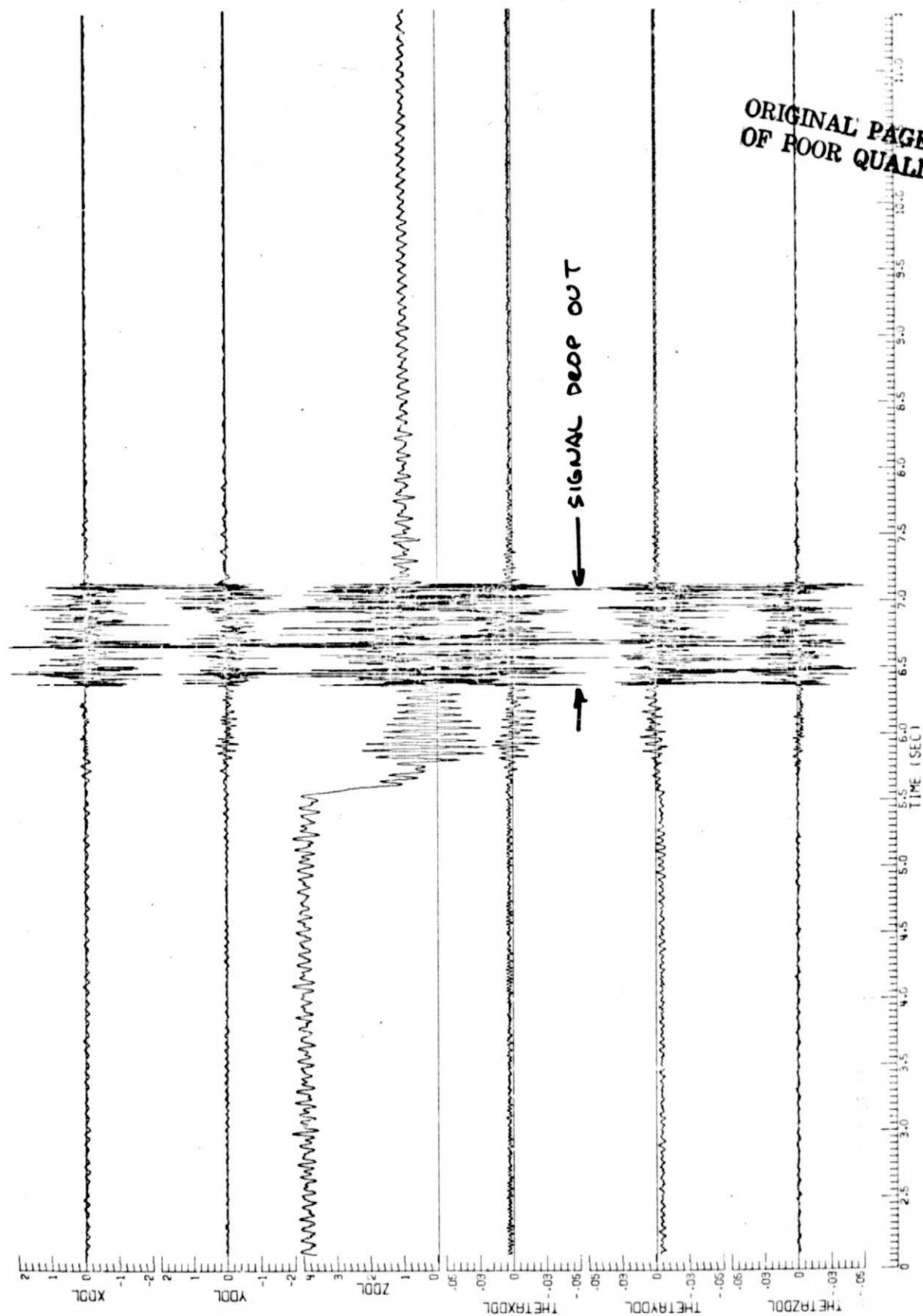
0 = 13:52:19 = 49939 Sec.

Figure 25. TC-1 Stage 1 Burn Out - Strain & Vib. - 1024 SPS



0 = 13:52:19 = 49939 Sec.

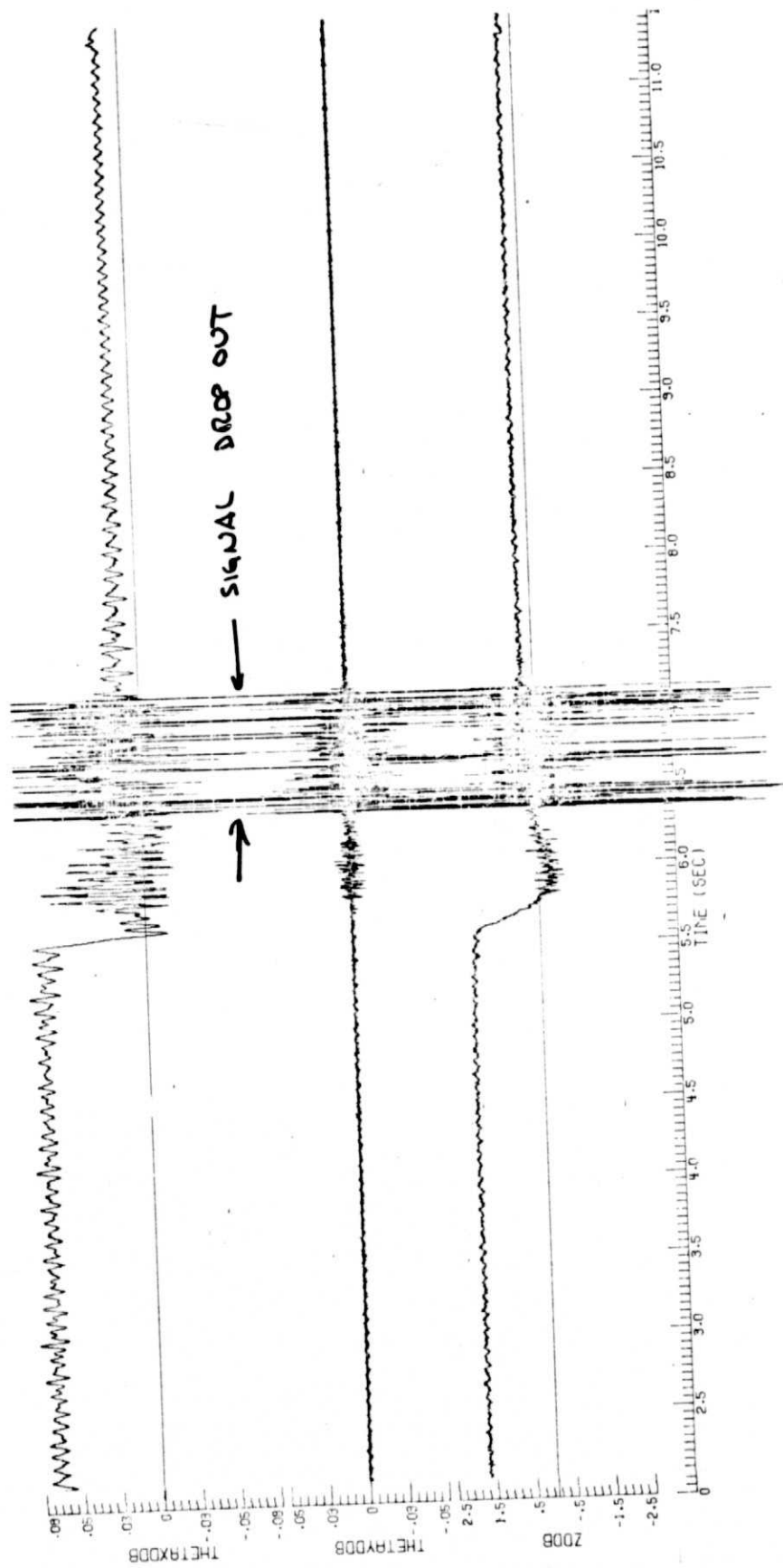
Figure 26. TC-1 Stage 1 Burn Out - Forces & Moments - 1024 SPS



ORIGINAL PAGE IS
OF POOR QUALITY

0 = 13:52:19 = 49939 Sec.

Figure 27. TC-1 Stage 1 Burn Out - VLC cg Acceleration 1024 SPS



0 = 13:52:19 = 49939 Sec.

Figure 28. TC-1 Stage 1 - Burn Out - Bus Accelerations - 1024 SPS